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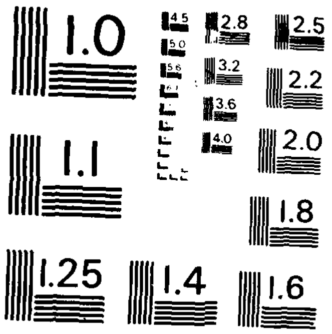

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A FIELD STUDY OF AIR FORCE ORGANIZATION STRUCTURES

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May 1984

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Changes in the political, social, economic, and technological environments of organizations have provided an increasingly turbulent context within which organizations must operate. One consequence of these changes is growing concern with developing structural forms which adapt more easily. The Air Force has also become interested in this issue and has requested study focusing on some "non-traditional" options to more traditional functional structure. This paper reports results of a pilot work for this effort. Included are a discussion of the importance of structure, theoretical models for structural variations and alternatives, a methodology which can be used to study structural issues, and an application of both methodology and theory to specific Air Force situations (aircraft maintenance and systems acquisition). Discussion is provided by answers to specific questions regarding structural issues in the Air Force.

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Preface

Some general background for this program of study is appropriate to help the reader understand the context of this portion of the entire venture. In 1981, the Director of Manpower and Organization of Headquarters United States Air Force requested research help in the area of organizational structures. Essentially, the request sought firm guidelines on advantages and disadvantages of various alternative structures and methods of organizing people for mission accomplishment. In particular, the request appeared geared toward the study of non-traditional organizational structures that might accommodate manpower savings or at least spread selected scarce resources most efficiently.

An underlying factor which compounds the problem in the study of organizational structures in the Air Force is changes which occur in the shift from peacetime to wartime operation. On the surface the shift may appear small; however, moving the focus from being <u>prepared</u> to defend the United States, to a more overt action of <u>defending</u> the United States and her interests has dramatic impact on structural decisions. While a primary concern during peacetime is efficiency, a necessary goal during wartime is effectiveness. The efficiency motive is driven by the Department of Defense's obligation to operate within a minimum budget, to include human resources. Historically, we know the size of our armed forces swells during protracted engagements. Additionally, as technologies change, methods and locations from which we conduct war change. History also demonstrates that our goals are often as much politically as military motivated and thus influenced. These factors (technology, environment, human resources and goals) and the change that occurs from peacetime to wartime compound the problem of determining appropriate structure. Indeed, an emergency situation is not a time to begin changing working units and relationships; the literature has long explained the turmoil created by simple organizational changes. Structural change is not the type of issue to face in such an inopportune time.

With that framework, the Leadership and Management Development Center research staff began design of a series of interconnected studies to define the elements of the problem, develop complete methods for capturing relevant data, determine appropriate analysis methods, and find ways to put the knowledge into a useable format. The initial step in the process began with independent study of organization theory concepts. While the staff was building expertise, initial studies by Air Command and Staff College students were begun under our advisement. Two of the initial papers were concerned with analytical attempts to understand the dynamics of matrix (a structure reported to be effective in use of scarce resources, but one nearly devoid of data-oriented study). The third served to help define "non-traditional" organizational structures. At the same time LMDC researchers and consultants began extensive work with a major research and development organization that used matrix management. Although much of the work was not conducted within the context of a pure research design (the relationship was driven by LMDC's expertise in management consultation), the experience over a three year period has brought greater understanding in the workings and frailities of a matrix. Additional papers are underway this academic year and will include an annotated bibliography and a framework for evaluating structures.

More directly related to the issues, LMDC held a workshop on organization structures in January, 1983. The purpose of this workshop was to determine the best way to study existing or hypothetical structures. Participants included organization theorists from academia as well as the USAF. The group was successful in determining an appropriate initial step for field study.

With the expertise of Dr. Dick Daft, Dr. Ed Conlon and Major Larry Short, we began pilot research during the summer of 1983. These data are the focus of this technical report. Considerable knowledge of the workings of Air Force organizations was gained and insights were disclosed within the context of two models. These insights and familiarization with Air Force structure, goals, technology, human resources, and environment set the stage for a more definitive follow-up which will move us one step closer to our goal.

Much of what is written here may seem like "nothing new" to those within each of the major functional areas studied. These data have come from peers of the readers whose purpose was to tell it to us "as it is." The contribution comes from framing the data in models so that generalizations or guidelines may be built. In fact, we hope that there are many expressions of "nothing new" from our accounts. This speaks to the validity of the data capturing method. The keys to this effort are the manner in which these data are tied together and in the next research effort.

We wish to thank USAF/LEY, TAC/LE, ATC/LE and commanders from the unnamed bases that allowed us to work in their organizations during this past summer. We pay tribute to these commanders who care enough about the Air Force to contribute to research to help decision makers in their efforts to make the Air Force an even better organization. Perhaps these commanders' willingness to contribute is best reflected by the overwhelming support provided by those selected for interviews. Those interviewed were impressive in their professionalism, knowledge, and concern for their organizations.

Appreciation is also due several other people. I would like to thank Drs. Daft and Conlon for their efforts which often exceeded the requirements of their contracts. We received a bargain in talent, enthusiasm, and research capabilities. Major Larry Short's broad range of research skills and experience also contributed heavily to the study. His expertise was critical from the design of the study to completion of the final report document.

Finally, we all appreciate the patience of those above us in LMDC and HQ USAF/MPM who allowed us the time necessary for an effort of this magnitude. We sincerely believe we are considerably closer to providing the Air Force with solid foundations upon which to aid commanders in the design of their organizations.

JEFFREY S. AUSTIN
Program Director

TABLE OF CONTENTS

	Page
Preface	ii
List of Tables and Figures	vii
Chapter One - Background	1
Air Force Perspective	2
Organization Structure Issues	4
Chapter Two - Methodology	30
Procedure	30
Subjects	31
Chapter Three - Results	32
Aircraft Maintenance	32
Systems Acquisition and Development	56
Chapter Four - Summary and Recommendations	68
Importance of the Study	68
Summary Questions and Answers	70
Future Work	74
A Final Comment	76
References	77

LIST OF TABLES

Table — Page

1. Comparison of Contextual Factors. 34

LIST OF FIGURES

Figure — Page

1. A Schematic of the Galbraith Framework. 8
2. Hypothetical Example of Functional Structure. 12
3. Hypothetical Example of Program (Decentralized) Structure 16
4. Hypothetical Example of Program Structure for Systems Development 17
5. Hypothetical Example of Hybrid Structure. 19
6. Example of Matrix Structure 22
7. Hypothetical Matrix Structure 23
8. Close-up View of Two-Boss Relationship in Matrix Structure 25
9. Relationship of Organization Structure to Efficiency vs Effectiveness Orientation 29
10. Typical 66-1 Organizational Structure 37
11. A Typical 66-1 Structure in ATC 41
12. A Typical 66-5 Structure. 42
13. A Contract Structure Under 66-1 45
14. Pre-Matrix Program Structure (Simplified) 58
15. Hypothetical Matrix Structure (Simplified). 59

CHAPTER ONE

BACKGROUND

Recent research literature indicates a great deal of information has emerged in the past ten years concerning various non-traditional approaches to designing organizations (see, for example, Daft, 1983). This interest has been sparked by an increased awareness of the environment and its affect on human resource management. Interest within the Air Force over the past few years has been highlighted by the numerous requests for research studies to investigate more efficient and effective ways of utilizing people.

The growing practice of using non-traditional organization structures is driven by the need to cope with rapidly changing technologies, unique customer requirements, and the need for multi-disciplinary teams to solve complex problems. Other key factors include financial and human resource constraints which impel managers to organize and utilize people in the most efficient way. Thus, changes in the political, social, and economic environments of organizations, coupled with the high rate of technological change, produce a turbulent environment. In this environment, an organization striving to maintain a dynamic relationship with forces in the environment finds it cannot substantially reduce the risks and uncertainty under which it must operate. The consequence has been growing concern with developing structural forms in the organization that will adapt more easily (Davis, 1979).

The Air Force has also become concerned about these issues. The purpose of this paper is, therefore, to document the results of a pilot research project designed to begin studying the intricacies of organizational structures within the Air Force. It is designed to set the stage for a methodical program of study on structural issues.

Air Force Perspective of Organization Structure

Functional grouping has been the traditional Air Force approach for many years. Air Force Regulation (AFR) 26-2, Organization Policy and Guidance (1982) emphasizes that the most effective functional groups are made up of functions that have a common goal. Additionally, AFR 26-2 requires that each part of a functional organization (1) be directed toward achieving a major goal; (2) constitute a logical, separable field of responsibility; (3) have a clear-cut charter that is definite in scope, purpose, objectives, and goals to achieve, with a single commander, supervisor, or staff member in full charge; (4) cover all the demands of a function that are closely related and constitute a complete entity; and (5) have easy, workable relationships with other parts of the organization, but with natural, definable divisions among them. Thus, USAF principles, objectives, and policies clearly indicate functional grouping is to be the predominant form of organization structure. However, in an organization as large and complex as the Air Force, the functional approach does not always apply, and variations or alternative approaches can be more effective.

Alternative techniques of structuring organizations evolve both in response to forces in the environment (external) of the organization and to needs internal to the organization (Davis, 1977). Typical external forces which can drive an organization to change its structure are competitor's actions, customer requirements, financial constraints, and scientific and technological knowledge. Internal pressures for change may be change in strategy or goals; change in tasks; change in psychological characteristics of its members (Lorsch, 1977); need to produce new, different, and more effective authority and work patterns; and redoing of basic procedural arrangements (Brown, 1979). New and different types of organization designs oriented away from functional grouping are continuously evolving. Ad hoc structures such as project or product grouping, matrix, parallel, consolidation, collegial, and committee are being used today to facilitate response to internal and external pressures.

Regardless of the organization design, it is important to realize the basic objectives of the Air Force organization as outlined in AFR 26-2. These are (1) to maintain a structure that operates effectively with the least expenditure of resources; (2) to standardize the organization structures as much as possible; (3) to keep pace with technological advances, changing missions, and concepts of operation; (4) to streamline the decision-making process; (5) to ensure that the organization of improvements in one part of the Air Force are applied elsewhere, when applicable; and (6) to develop organizational nomenclature that has precise meaning throughout the Air Force.

HQ USAF/MPM (Headquarters, United States Director of Air Force Manpower and Organization) has requested studies be conducted to investigate non-traditional methods of organizing people and skills. According to a letter from MPMO, dated 4 Dec 81,

> "The Air Force does not have a capability to make an objective, a priori comparison of the advantages and disadvantages of alternate techniques of organizing and utilizing people to accomplish mission requirements."

Subsequently, the Leadership and Management Development Center (LMDC) at Maxwell AFB AL has initiated studies to address this problem. This paper reports on the issue of developing a methodology for addressing this long term assignment.

Organization Structure Issues

Definition of Structure

The structure of an organization is reflected on the organization chart. The organization chart represents a number of underlying activities and processes within organizations. The key components in the definition of organization structure include (Child, 1977; Daft, 1983):

1. Organization structure describes the allocation of task and responsibilities to individuals throughout the organization. The structure also specifies tasks and degree of specialization.
2. Organization structure designates formal reporting relationships, including the number of levels in the hierarchy and the span of control of managers and supervisors.
3. Organization structure specifies the grouping together of individuals into departments and the grouping of departments into the total organization.
4. Organization structure includes the design of subsystems to ensure effective communication, motivation, and coordination of effort in both vertical and horizontal directions. Examples of subsystems include rules and procedures, performance appraisal, planning and budgeting systems, liaison positions, teams, and task forces.

The Importance of Structure

When structure fits the needs of the organization, it is hardly noticed. The division of labor, the allocation of resources, the grouping of departments, formal reporting relationships, and systems for information and coordination are in alignment and the organization achieves its performance objectives. When structure is correct, both managers and employees are satisfied with working relationships. However, when organization structure is incorrect, when it is out of alignment with organization needs, one or more of the following problems may appear (Child, 1977; Duncan, 1979).

When structure is incorrect, the organization does not respond quickly or innovatively to environmental changes. One important reason for lack of response is that employees are focused on needs within their department, hence coordination across departments is not achieved. Organizational responsiveness requires that the organization react as a coordinated whole, and departments must cooperate with one another. In addition, the structure should allocate resources to scan the environment and to plan for anticipated changes.

When structure is incorrect, too much conflict will be evident. Departments may be pursuing goals that are at cross purposes. Individuals may be under pressure to accomplish departmental goals and to avoid cooperation with others. When people meet at the interface between departments, they may disagree about procedures and required tasks. The organization has not been structured in a way to deal with conflicting goals and priorities within the organization. The organization should be structured into a compatible set of objectives and priorities.

When structure is incorrect, managerial decision making may be delayed or lacking in quality. Managers at the top of the organization may be overloaded with decisions because the hierarchy funnels too many problems to them. The delegation of responsibility to lower levels may be insufficient. Another problem is that information may not reach the correct people. Necessary information is not transmitted to the people in the best position to make the decision. The absence of information from around the organization may reduce decision quality. Also, decision makers may be segmented. The organization structure may not integrate diverse interests into the decision making process.

When structure is incorrect, employee motivation and morale may be depressed. Within the organization, employees may believe that decisions are inconsistent and arbitrary. Employees are also subject to competing pressures from different parts of the organization. Employees and supervisors may have to leave their jobs to obtain parts or tools directly from other departments because their support systems are not adequate. Finally, employees may perceive they have little responsibility, advancement opportunity, or recognition when structure is incorrect.

When structure is incorrect, resource utilization may be uneven. In some departments, the organization may have excess resources. People, equipment, or facilities may not be fully utilized in the accomplishment of organizational tasks. In other departments, resources will be insufficient. There are not enough people, equipment, or facilities to accomplish high priority tasks. The division of labor and allocation of resources to reflect organizational tasks and priorities is a primary function of structure, and too few or too many resources indicates a structural deficiency.

When structure is incorrect, the organization will not achieve performance goals. Performance deficiencies will be felt in various ways: specific targets are not met or people associated with the organization feel it should be doing better on a variety of dimensions. The sense of performance deficiency may be caused by too much conflict, slow response to external changes, poor decision making, low morale, or poor resource utilization, all of which may have their roots in the incorrect organization structure. Managers and employees often can overcome structural deficiencies through commitment and hard work. But when structure is severely out of alignment with organizational needs, the eventual outcome will be reduced organizational performance.

Sources of Structural Variation

This section of the report presents a framework for understanding organization structures. The framework, adapted from Galbraith (1973; 1977), views structure as highly interdependent with a number of additional organizational characteristics. Like most modern perspectives on organizational design, this framework sees the structure utilized by an organization as a variable aspect of the organization's strategy. More specifically, the choices of how an organizational unit should be structured are part of the general strategic decision process and cannot be made independently of decisions regarding the organizations goals, the technology used to pursue those goals, the environments in which the organizanization will function, and its people. The structure utilized by an organizational unit depends (or should depend), therefore, on other aspects of the corporate strategy. Galbraith identifies four such elements which are (1) goals and objectives, (2) environment, (3) human resources, and (4) technology. The network of interrelationships is shown in Figure 1.

The goals and objectives are determined, in the case of the Air Force, by a unit's mission. For example, a goal common to Tactical Air Command (TAC) flying wings is the ability to deploy (i.e., move base of operations) to

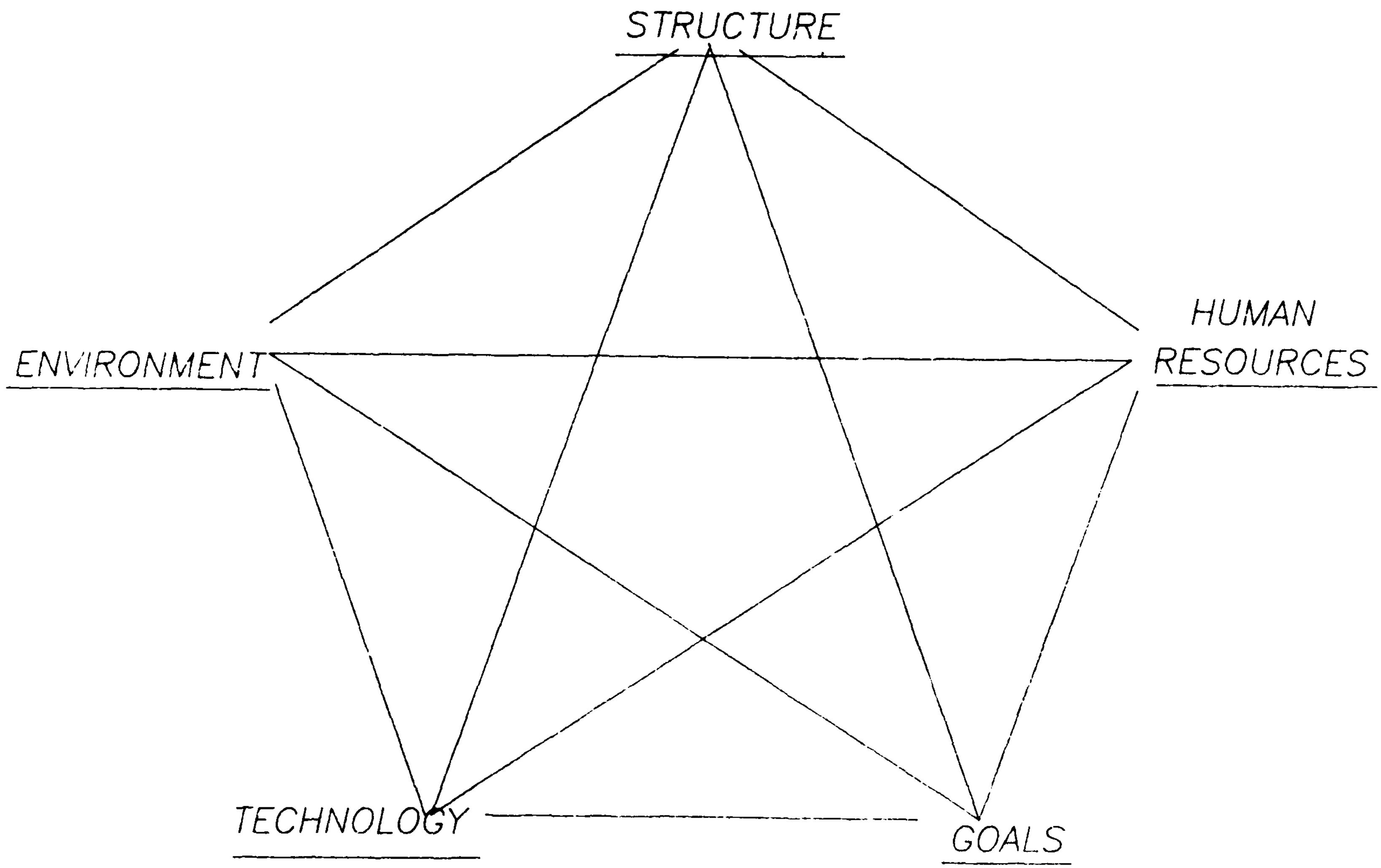

FIGURE 1. A SCHEMATIC OF THE GALBRAITH FRAMEWORK.

anywhere in the world within a particular time frame with no loss in operational capability. A goal of Strategic Air Command (SAC) wings is to have a specific number of aircraft mission ready (i.e., armed and ready to fly) within minutes of an alert. A goal of Air Training Command (ATC) with respect to flying missions is to provide initial training for all pilots and other flight crew members at a rate determined by the manpower needs of the Air Force. Structures are adaptations to the demands placed on an organization.

SAC, for example, requires a relatively small proportion of aircraft in any particular wing to be on alert. For this reason, among others, those aircraft currently on alert are typically "self contained," meaning that they are serviced by a set of resources (i.e., plant, people, and equipment) that are not shared with aircraft not on alert. If one were to begin to increase the required number of aircraft on alert without increasing the resources available, at some point the self contained structure would become infeasible and another structure would replace it.

The environment of an organizational unit consists of those elements outside of its boundaries with which it must interact. For example, Air Force maintenance units are dependent on units outside the maintenance function for spare parts. These parts suppliers are a critical aspect of the unit's environment. The availability of parts, the procedures used to obtain them, and the time frame for delivery can all affect structure. The more complicated the procedures for obtaining parts, the more likely one would find a specialized role or office inside a maintenance unit interfacing with the supply environment.

Human resources are the manpower pool from which the unit must draw. Important aspects of this pool include the level of skills, and the level of training and motivation. For example, military maintenance units must cope with a work force that may completely change every three to five years. To the extent that this implies the need to train new people, the span of control may be narrowed to facilitate such training and to prevent costly errors.

The technology of a unit consists of the array of operations necessary to conduct the unit's mission, the particular means by which each operation is performed, and the degree of interdependency among each operation. The latter notion, interdependency, places important limitations on structure. As a general rule, it is not desirable to structurally separate the performance of tasks that have complex interdependencies with one another. It might be better to have a single work unit perform the entire task than to face the problem of communicating a large set of complex contingencies.

Organizational structures can be critically evaluated with regard to how well they are adapted to the environment, technology, goals, and human resources with which they must function. Because these interrelationships are often complex, there is no clear cut set of rules governing such adaptation. For a particular situation, however, it is possible to examine the existing structure as a response to the demands and constraints placed on it by the four factors. It is also important to consider the general framework that structures have historically followed.

Description of Structural Alternatives

The structural allocation of responsibility, division of labor, and grouping of departments within organizations typically follow one of four structural forms. These structural forms are reflected in the design of the organization chart and are typically identified as follows:

1. Functional structure. Also called centralized or line and staff structure. People and departments are grouped together by common functional activity.
2. Program structure. Also called product structure, decentralized structure, self-contained units, or structure for self-sufficiency. People and departments are grouped together by program, product, or geographical area.
3. Hybrid structure. Part of the organization has a functional structure and part has a product structure to gain advantages of each.
4. Matrix structure. Product and functional structures are implemented simultaneously and overlay one another. This is a complex form of structure used only for unique circumstances.

Each form of organization structure serves a distinct purpose and has advantages and disadvantages for the organization. A specific structure should be adopted based upon advantages for the organization's specific needs. Examples of each type of structure and their strengths and weaknesses are discussed below.

Functional (Centralized) Structure

A hypothetical example of a functional structure for one organization is in Figure 2. Employees are grouped together by functional activity. All

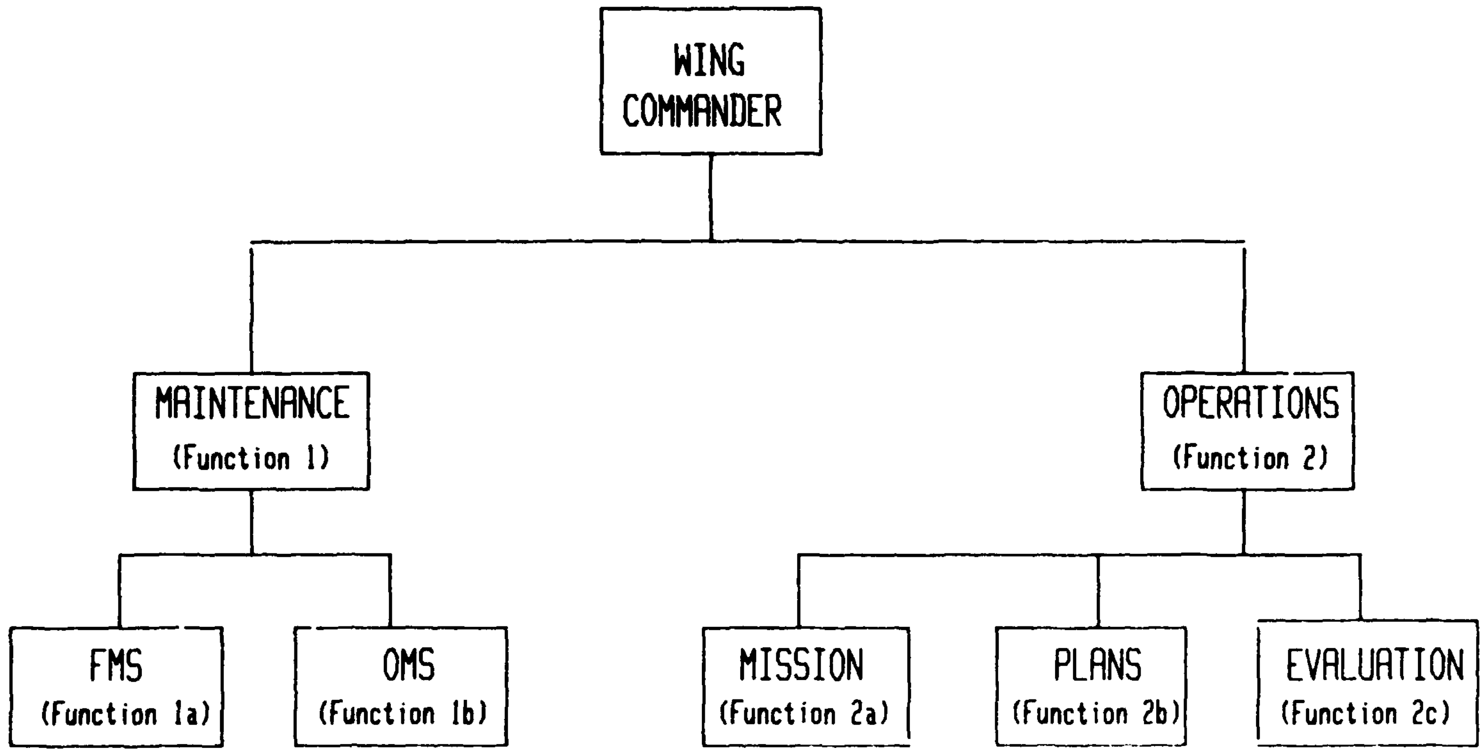

FIGURE 2. HYPOTHETICAL EXAMPLE OF FUNCTIONAL STRUCTURE.

maintenance people are located within respective maintenance departments, operations people are within the operations groups, and so on. This organization is centralized because the point at which the functions converge is at the top of the organization. Major decisions and issues are resolved by the wing commander. This structure often has extensive subsystems in the form of rules, policies, budgets, planning, and appraisal systems to assist the commander.

Advantages. The functional form of organization offers a number of advantages:

1. Efficient use of scarce resources. Common activities are grouped together so that the available skills and resources can be allocated to meet demands with greatest efficiency. Employees are pooled and can be assigned to a variety of jobs. No duplication of personnel or resources are required.
2. In-depth skill development. Specialists have many training opportunities to deepen their experiences within the function. Promotion is based on functional skills.
3. Employees identify with functional departments and functional goals. They wish to excel at functional activities. Functional goals and activities receive priority.
4. Rules, regulations, planning, and schedules are used for coordination and control. Departments thus can work somewhat autonomously and still achieve organizational goals.

Disadvantages. The functional organization may also contain certain problems and disadvantages for the organization:

1. Slow response time to environmental changes. The functional organization structure tends to be locked into one mode of behavior and major changes that require coordinated effort are difficult to implement.

2. Decisions may pile on top, causing overload for top managers. This is especially true for decisions that require coordination across functions, or when adequate planning, scheduling, and information systems are inadequate.

3. Poor interdepartmental coordination. Employees identify with their own departments and are reluctant to compromise with other functional departments. Task forces, liaison personnel, committees, and other face-to-face devices may be needed to help achieve coordination horizontally across departments.

4. Employees have a restricted view of organizational goals. Employees identify with their functional goals, so decisions and activities within functional departments may be at cross purposes with overall organization goals.

Context for Functional Structure. Based upon the discussion of variation in structural contexts, the functional form of organization works best in the following situations:

1. When the overall organization task and technology are predictable, definable, independent, and routine.

2. When environmental demands placed upon the organization are consistent, stable, and predictable.

3. When the efficient use of internal human and physical resources is a major goal of the organization.

4. When employee training, competence, and specialization is important to the accomplishment of organizational outcomes.

Program (Decentralized) Structure

The program form of structure groups employees by desired organizational outcome rather than by functional activity. Figure 3 illustrates a hypothetical program organization. The wing is divided into three self-contained units. Each unit is independent because it contains all necessary functions. This structure decentralizes decision making to a level beneath the wing commander. The functional activities converge on the organization chart at the flight level where major problems and decisions are made. Another example of program structure is in Figure 4. This figure is representative of a hypothetical product division. Each program is self-contained with respect to the engineers, manufacturing, comptrollers, and contracting personnel needed for systems acquisition and development.

Advantages. Some of the advantages of the program or decentralized form of structure include:

1. Suited to fast change. Each self-contained unit is small, and employees have easy access to one another across functions. Units are mobile and flexible because they are small in size, have efficient coordination, and are independent of one another.
2. Conflict across functions is minimized. Employees identify with the overall program and readily cooperate with other functions to accomplish program outcomes.
3. Organizational goals take precedence over limited functional goals. Employees focus on achieving the goals of the program or the flight.

Disadvantages. Some of the weaknesses of the program or decentralized form of structure are as follows:

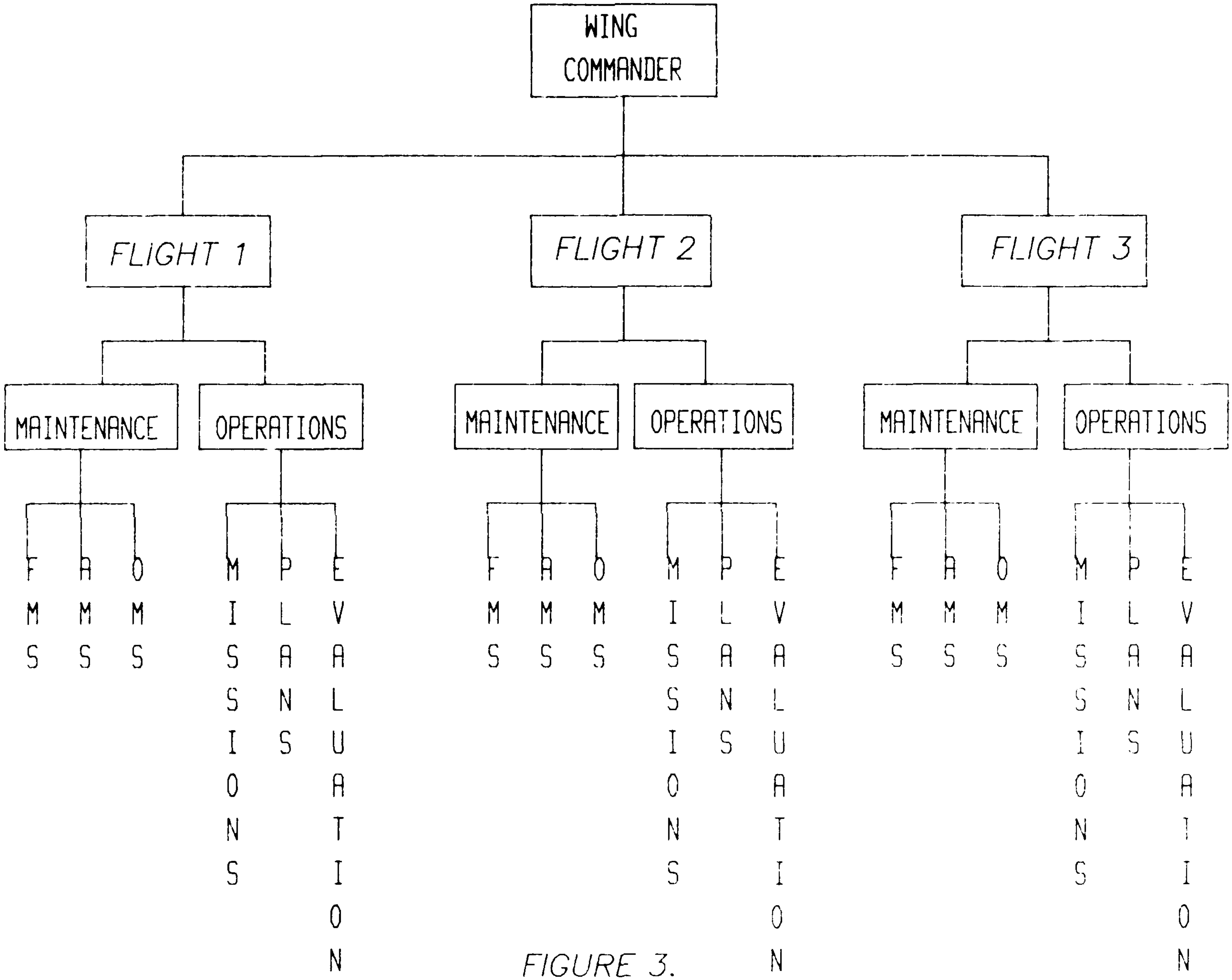

FIGURE 3.

HYPOTHETICAL EXAMPLE OF PROGRAM (DECENTRALIZED) STRUCTURE.

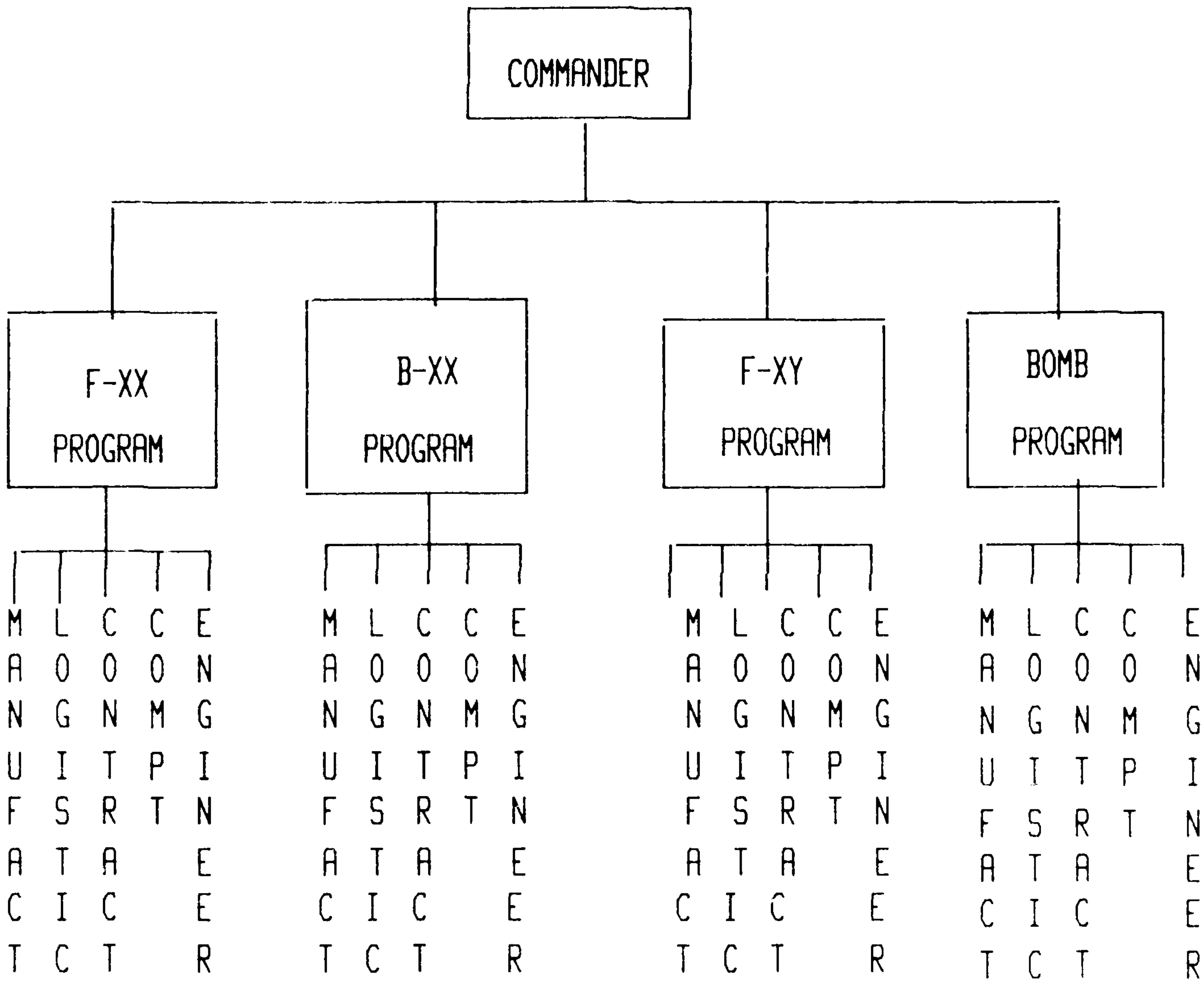

FIGURE 4.

HYPOTHETICAL EXAMPLE OF PROGRAM STRUCTURE FOR SYSTEMS DEVELOPMENT.

1. Duplication of resources across units. The program organization requires a larger amount of personnel and physical resources to make each unit self-sufficient.

2. In-depth competence and technical specialization is lost. Employees have fewer opportunities to specialize, and they tend to become generalists. Employees may work across a number of functions within each self-contained unit.

Context for Program Structure. The program form of organization works best in the following circumstances:

1. Overall organization task and technology are interdependent across functions and demand extensive coordination.

2. The environment is unpredictable and unstable. Organizations must respond to unexpected demands and changes.

3. The organization is large enough that sufficient resources are available to assign to self-contained units.

4. Goals of flexibility, immediate response, and coordinated effort are more important than goals of efficiently using internal resources.

Hybrid Structure

The hybrid structure contains elements of both functional and program structural forms as hypothetically illustrated in Figure 5. Certain departments are structured into self-contained units while others are grouped by function and report to the wing commander. The product groups are not completely self-sufficient, and contain only those activities that require a high level of coordination and adaptability. The departments that are grouped by

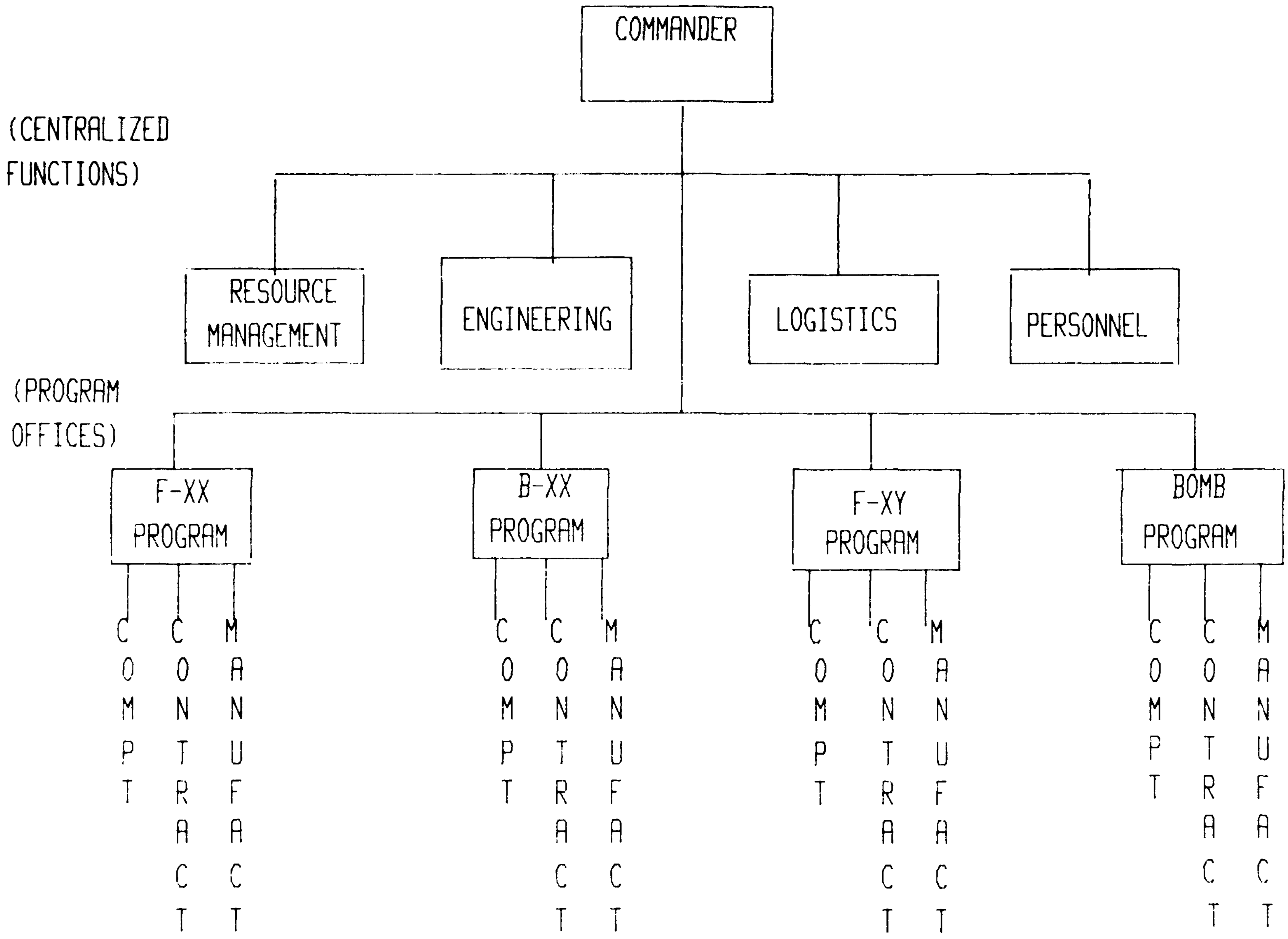

FIGURE 5. HYPOTHETICAL EXAMPLE OF HYBRID STRUCTURE.

function typically have stable demands and require in-depth training and specialization for employees.

Advantages. The advantage of the hybrid structure over program and functional forms are as follows:

1. The organization is able to meet the needs for adaptability and coordination among a subset of departments without having to assign every functional activity to the programs.
2. The organization can achieve efficiencies in the use of functional resources in those parts of the organization that are stable and independent.

Disadvantages. Disadvantages of the hybrid form include:

1. The overall mission of the organization may be unclear. Parts of the organization are structured to encourage coordination and flexibility, and other parts to emphasize efficiency and stability.
2. The organization will need structural mechanisms to coordinate the functional and program areas. Liaison relationships may be needed to ensure that the functions provide the appropriate services to the product groups.

Context of Hybrid Structure. The hybrid structure is typically used in circumstances slightly different from program and functional structures:

1. The organization is large enough so that sufficient resources are available for partially self-contained units, yet small enough to need efficiencies in certain functional areas.
2. The organization has two distinct task requirements: one set of tasks that are less routine and require extensive coordination, and one set which are routine and relatively independent.

3. The organization experiences two distinct goals to meet environmental demands. One goal is for flexible, adaptable response to achieve effective outcomes, and the other goal is for the efficient use of certain functional resources.

Matrix Structure

The matrix structure is unique because it incorporates both functional and program lines to authority simultaneously as illustrated in Figure 6. The matrix structure is different from the hybrid structure, although both structures try to accommodate both program and functional needs. The hybrid structure, as described above, organizes one part of the organization into a program structure and another part into a functional structure. The matrix form of structure, by contrast, utilizes both structures simultaneously in the same part of the organization. Thus, many employees experience a dual line of authority: they report to one boss who is in charge of a function and to another boss who is in charge of a program. The outcome is an organization designed to do two things simultaneously for every department: (1) achieve efficient use of personnel and physical resources through the functional hierarchy; and (2) achieve adaptability, coordination, and program goals through the program side of the hierarchy.

A hypothetical use of the matrix structure in the Air Force Systems Command (AFSC) is illustrated in Figure 7. Each program office is designed as a self-contained unit. The program office is responsible for coordinating resources to complete program objectives. However, supervisors within each program also report laterally to a functional director. The functional director is responsible for personnel training, performance appraisal, technical

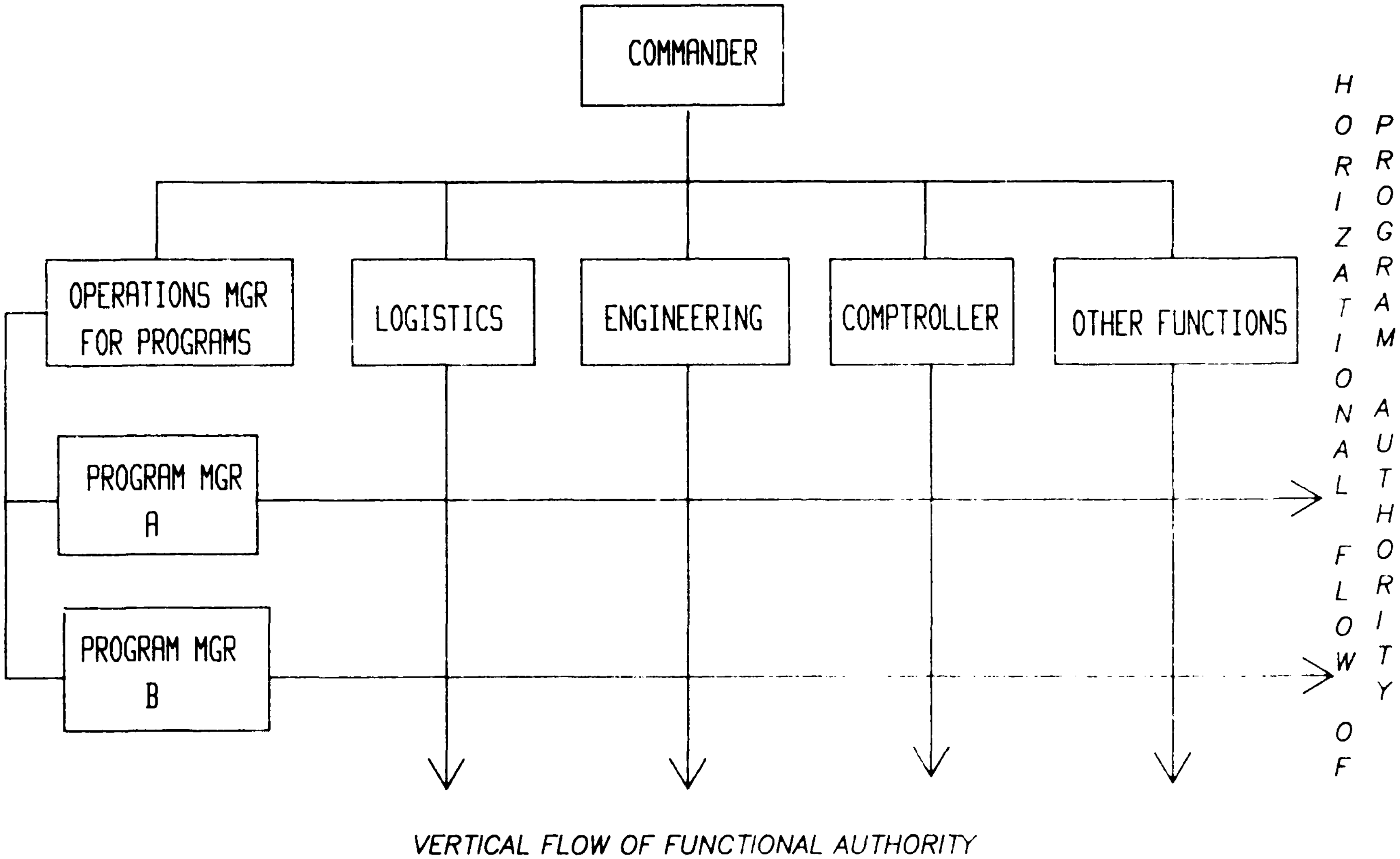

FIGURE 6. EXAMPLE OF MATRIX STRUC[illegible]E.

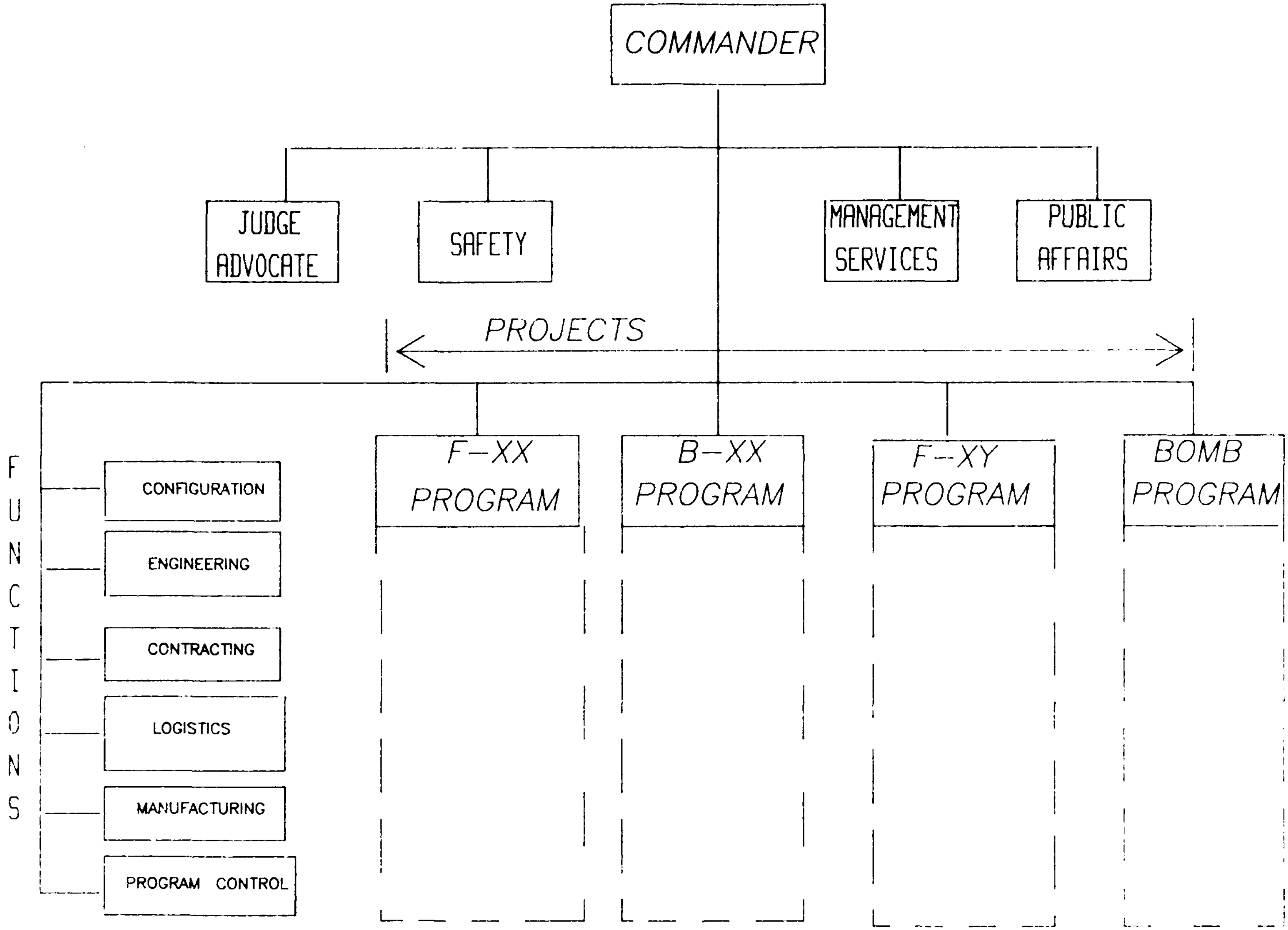

FIGURE 7. HYPOTHETICAL MATRIX STRUCTURE.

standards, technical quality. The functional director also balances scarce resources across programs.

A close-up view of reporting relationships within a program is illustrated in Figure 8. The chief engineer in the F-XX program reports to both the F-XX program director and to the engineering director. In this matrix, the engineering supervisor and other supervisors at the same level report to two bosses. Lower level engineers report to the senior engineer for day-to-day activities. Typically, only one level in the matrix hierarchy reports to two bosses. This level is responsible for balancing the dual demands of efficient personnel utilization and program adaptability and coordination.

Advantages. The matrix structure, although unique, does offer advantages to certain types of organizations:

1. More efficient use of human resources than occurs under the program structure because people are not assigned full time to one program. Scarce personnel resources can be assigned part time to more than one program or can be reallocated from one program to another as program priorities change.
2. Provides a functional "home" for specialists so that training, skill development, and career progress are enhanced.
3. The matrix organization is able to respond to competing pressures simultaneously, such as for efficient resource utilization and for adaptability.
4. Encourages extensive coordination and communication in the form of meetings and discussions across programs and functions, which enables the organization to cope with an uncertain environment and to make frequent changes while using scarce resources efficiently.

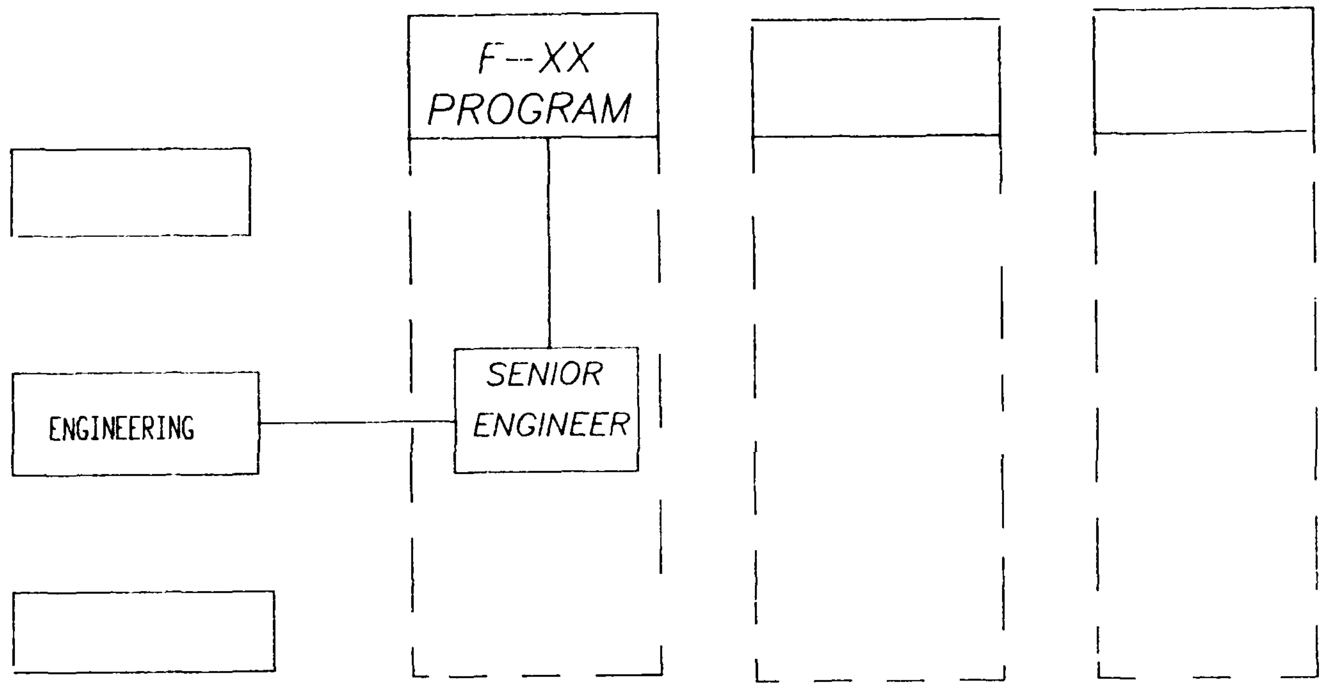

FIGURE 8. CLOSE–UP VIEW OF TWO–BOSS RELATIONSHIP IN MATRIX STRUCTURE.

Disadvantages. The matrix structure also carries with it distinct problems which have to be managed if it is to succeed:

1. Some employees experience dual authority, which can be frustrating and confusing. Employees may never be sure whether their commitment is to the program or to the function.
2. Employees need excellent human relations skills as well as technical skills. Human relations training is required because of frequent meetings and discussions needed to resolve conflicts and to coordinate functional and program demands.
3. Employees must have a "corporate" mentality and see the big picture, otherwise compromise and give-and-take required to meet conflicting demands will be thwarted.
4. Administrative costs are high, both in terms of time spent in meetings and additional administrative positions. The savings gained by sharing technical specialists across multiple programs are frequently offset by additional costs in administrative time and personnel.

Context of Matrix Structure. The organizational context to which the matrix is suited is as follows:

1. Organization technology and tasks are non-routine, intangible, and interdependent, thus requiring extensive analysis and coordination.
2. The environment is unstable, with changing demands for program priorities and with new programs being requested.
3. The organization is medium sized and has multiple programs operating simultaneously.
4. Organizational goals require both flexibility/adaptability and the efficient use of scarce resources at the same time.

Efficiency vs. Effectiveness

The discussion of structural alternatives has presented four types of structure - functional, program, hybrid, matrix - and their advantages and disadvantages. Each form of structure is suited to a specific context with respect to environment, technology, human resources, and goals.

An underlying theme that governs the use of these structural alternatives is efficiency vs. effectiveness. Organizations cannot maximize everything at once. Top administrators must make choices. Organization structure can be slanted toward achieving internal efficiency or toward achieving effectiveness in response to external demands. Organizations that are structured to achieve internal efficiency typically exist in stable environments and have technologies that are routine and predictable. These organizations try to make the most efficient use of human resources. At the opposite extreme are organizations that must ignore internal efficiencies in order to accommodate explicit demands for external effectiveness. These organizations must respond to changes in the external environment and work with the technologies that are non-routine and unpredictable. These organizations must be designed for innovation and coordination.

These two structural orientations - internal efficiency versus external effectiveness - are mutually exclusive. An organization designed to maximize one will lose the other. Managers thus must identify the basic purpose and context of the organization and design the structure to fit them. The use of the four structures described in this section--functional, product, hybrid, matrix-provide different approaches to accommodate efficiency and effectiveness demands.

Figure 9 illustrates a continuum anchored at each end by internal efficiency and external effectiveness. As illustrated in Figure 9, the functional structure is most appropriate for an internal efficiency orientation. The functional structure is very efficient, but does not work if the organization must be flexible, innovative, or work with non-routine technologies. The program structure, by contrast, is designed to maximize external effectiveness. Each self-contained unit is flexible and innovative. The program structure can respond quickly to the environment, but at a loss of internal efficiency. Resources are often duplicated among units and standardization is lost.

Figure 9 also illustrates how the hybrid and matrix forms of organization present intermediate structures that strive to provide elements of both internal efficiency and external effectiveness. The hybrid structure achieves efficiency and effectiveness by subdividing the organization into separate parts - one part (program structure) is designed for flexibility and innovation, and the other part (functional structure) is designed for internal efficiency. The matrix structure attempts to use both product and functional structures simultaneously. This design achieves elements of both adaptability and efficiency for all departments in the organizations. If demands to achieve both technical efficiency and program effectiveness are high, administrative costs will also be high.

In summary, each form of structure offers distinct advantages, depending upon the purpose and context of the organization. The wrong organization structure can cause severe problems because the organization will not be aligned with technology, environment, and purpose. The correct structure will enable the organization to maximize those factors most important to the organization's goals and mission.

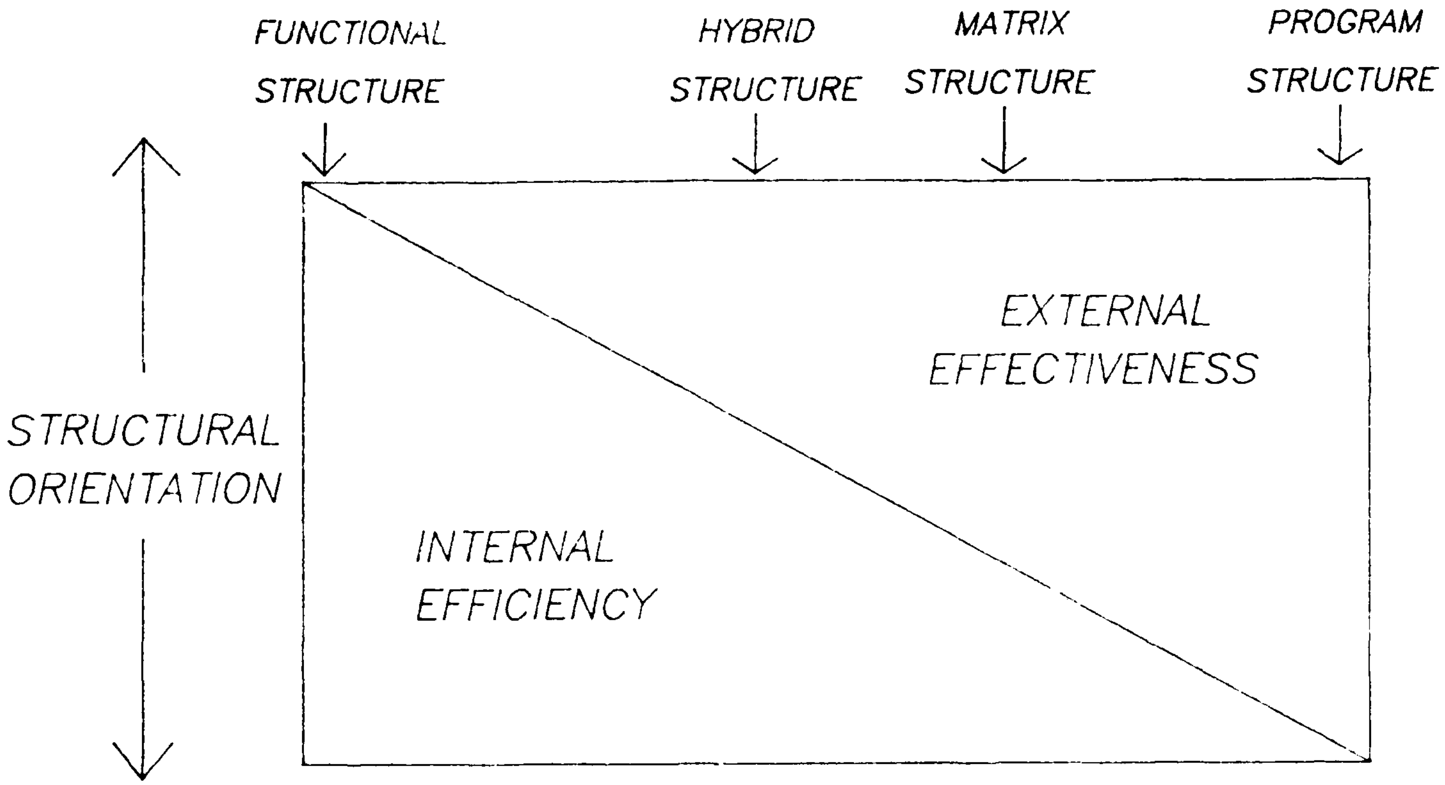

FIGURE 9. RELATIONSHIP OF ORGANIZATION STRUCTURE TO EFFICIENCY VS EFFECTIVENESS ORIENTATION.

CHAPTER TWO

METHODOLOGY

Procedure

Data used in the initial pilot work were collected through a series of structured interviews across selected bases within several major Air Force commands. Four experienced interviewers were used during the data gathering phase. The interviews were standardized to the degree that two forms were developed to guide the interviews. Daily meetings were held to discuss problems, terminology, trends, and common themes.

Two separate sets of data were collected. One set of data focused on the Air Force aircraft maintenance community, and the Galbraith model served as the analysis focus. These interviews solicited information concerning the nature of the job, the mission and associated goals, amount of change inherent in the job requirements, interaction and communication patterns, climate and organization structure. In particular, structure questions focused on the differences in the two major organizational methods that currently exist in maintenance. Those interviewed were also requested to comment on particular strengths and weaknesses of the structures from their own viewpoint. Finally, effectiveness criteria were discussed.

The other major functional area that contributed to this effort was that associated with research and development organizations. The structures generally studied were varying forms of product/project management, most typically in some form of matrix structure. Data requested included information about the job and its associated complexity, mission and goals, amount of change, interaction and communication patterns, climate and structure.

Particular emphasis was directed to interaction patterns in this fairly complex arrangement. Once again, we sought information regarding particular strengths and weaknesses and measures of effectiveness. The structures were evaluated in terms of the efficiency/effectiveness continuum.

Interviews were scheduled for one hour, although the actual duration varied. Generally, the lower in the organization, the less knowledge and experience the individuals had with the issue of structure. Nonetheless, their input was valuable in assessing job demands and communication interaction patterns. Most interviews were conducted in uninterrupted neutral office settings. Researchers were afforded an introductory overview of mission and structure before each set of site interviews began.

Subjects

Our subjects included personnel from eight different sites. We interviewed at total of 74 people within the matrix structures and 106 people from varying maintenance structures. The data were gathered in 20 days during a July through August (1983) time period. The people were selected by the research team by position to insure both representativeness and consistency across units. The selection was purposely stratified at a high management level to help quickly assertain more global issues and to assure widest amounts of varying experience in organizations. Nevertheless, the grade range included colonel through senior airman to insure valuable insight would not be lost.

CHAPTER THREE

RESULTS

Aircraft Maintenance

This section of the report provides an analysis of three different organizational designs that are currently used within the Air Force for aircraft maintenance. For the sake of convenience, these will be referred to using the following labels: centralized (66-1), decentralized (66-5), contract. 66-1 and 66-5 are the numbered regulations which governs each type of design. Contract refers to the design used in a facility where maintenance is performed by a civilian contractor under general 66-1 guidelines. Of these three designs, 66-1 has been used the longest and is often thought of by experienced maintenance personnel as the "traditional" way to organize for aircraft maintenance. This design is used throughout the Strategic Air Command (SAC), the Military Airlift Command (MAC) and in most of Air Training Command (ATC). 66-5 is a newer design which was developed during the mid-1970's and was implemented by the Tactical Air Command (TAC) between 1976 and 1978 and adopted by the United States Air Force Europe (USAFE) and the Pacific Air Force (PACAF). It replaced the use of 66-1 in TAC. The contract design is used by a contractor in ATC who, although mandated by regulation 66-1, has developed a design which implements 66-1 in a way that is in some ways different from its military implementation. An implementation of 66-1 in ATC is included for comparison.

The objective of this analysis was to examine each of the designs in the context of modern theories of organizational design. Although the temptation was to try to compare designs across performance indicators such as various measures of effectiveness or output, organizational theory teaches that such comparisons must, at best, be made carefully. In the case of these three designs, because each was used in a different command context, it was virtually impossible to separate the effects of the various designs from sundry other potential "causes" of performance such as differences in mission, equipment, and tasks. As an alternative, each structure was reviewed using the Galbraith model presented earlier. It was expected that this model would indicate the extent to which each structure "fit" its context and would help to understand problem areas in the structure. Table 1 summarizes these differences.

Contextual Differences Among Installations

An analysis of structure using the Galbraith framework requires a review of the essential differences between the installations in terms of goals, technology, environments, and human resources.

Goals. The missions of the maintenance units at all units share one common goal: to produce a sufficient number of mission capable aircraft so that the operational goals (i.e., flying schedule) may be safely met. This goal implies adherence to regulations regarding operational specifications, technical orders, regular inspections, and other quality controls. Key differences between the installations (and major commands) concern the frequence with which aircraft are launched and recovered, the duration of a mission, and the requirements for wartime readiness. SAC flying missions are less frequent and of longer duration than TAC or ATC missions. For example, a "representative aircraft" at the SAC installation may fly three missions per week, whereas a TAC fighter may fly three to four per day and an ATC trainer four to five per day. A SAC flying mission may last ten hours whereas a fighter or trainer mission typically lasts two to four hours. SAC and TAC also have specific "readiness" requirements. In SAC, each installation has a

TABLE 1
A COMPARISON OF CONTEXTUAL FACTORS

CONTEXTUAL FACTORS	SAC	TAC	ATC CONTRACT	66-1
GOALS				
-FLIGHT RATE	SEVERAL/WEEK	2-4/DAYS	4-6/DAYS	
-FLIGHT DURATION	6-12/HRS	2-5/HRS	1-2/HRS	
-WARTIME READINESS	ALERT AIRCRAFT	DEPLOYMENT	NONE	
TECHNOLOGY				
-AIRCRAFT COMPLEXITY	MANY COMPLEX SYSTEMS	FEW COMPLEX SYSTEMS	LOWER COMPLEXITY OF SYSTEMS	
ENVIRONMENT				
-WARTIME LOCATION	SAME AS PEACETIME (CERTAIN)	UNKNOWN (UNCERTAIN)	SAME AS PEACETIME (CERTAIN)	
HUMAN RESOURCES				
-LABOR POOL	MILITARY	MILITARY	CIVILIAN	MILITARY
-RANGE OF EXPERIENCE	LOWER-HIGH	LOW-HIGH	HIGH	LOW-HIGH

requirement for a number of aircraft to be kept on alert -- armed and ready to fly within several minutes after a command is given to initiate the alert mission. In TAC, units are required to be ready to deploy anywhere within hours. ATC's wartime mission involves an increased rate of flying training and damage assessment.

Technological Differences. There are many commonalities among the installations in the technology of maintenance. All of the aircraft have jet engines, hydraulic systems, electrical systems, sheet metal bodies, and fuel systems. The technology of launching and recovering the aircraft is basically the same across installations. Important differences exist, however, in the complexity of the aircraft. SAC flies more complex systems than TAC, and TAC flies more complex aircraft than ATC. This ordering is based on an evaluation of the number of systems present on each type of aircraft and their complexity. B-52 bombers, a SAC aircraft, have more complex navigational, weapons, and electronic warfare systems on board than do F-4 fighters. T-37 and T-38 trainers are relatively simple aircraft with minimal avionic systems and no weapons or electronic warfare systems. The number of engines in each type of aircraft follows the same trend. All things considered, there is more to go wrong on a B-52 and less to go wrong on a trainer (T-37/38), and the things that can go wrong are more difficult to diagnose and repair on the more complex aircraft.

Environmental Differences. The only major environmental difference among the installations is related to differences in wartime missions. Both SAC and ATC operations are designed to be conducted at one place, the home base. In contrast, TAC is expected to operate in proximity to the battle theatre and must be able to deploy and operate out of facilities as meager as a simple airstrip. The difference is one of environmental uncertainty. SAC and ATC know their venues, TAC does not, and must be prepared to function across a wide range of settings. The Air Force itself is the common environment for all of the installations. It is the Air Force that supplies parts, manpower, and budget priorities. The Air Force itself, therefore, is an essential determinant of the environment faced by each installation.

Human Resources Differences. SAC and TAC both draw from the same (military) manpower pool and are, therefore, equivalent on this dimension. They also face the same issues with regards to the length of tours and required levels of staffing. The military ATC installation (66-1, ATC) is equivalent to the SAC and TAC bases. The big difference occurs with the contract installation. The contractor draws from a civilian and retired military labor pool and is not constrained by military manpower regulations or pay grades. The human resource pool at the contract base, therefore, is more experienced than at comparable military installations. The contractor is more concerned with retention and less concerned with training.

The above differences seemed to account, logically, for some of the differences in the structures and work practices used at each base. The interviews suggested that they were also related to some of the problems that are characteristic of each installation. We turn now to a description of the three structures and the key differences among them.

A Comparison of The Structures Across Installations

The four structures are displayed in Figure 10, Figure 11, Figure 12, and Figure 13. It should be noted that these figures are generalized structures which may not include all possible variations.

As is evident from Figure 10, 66-1 contains four major subdivisions (squadrons) all linked by the office of the Deputy Commander for Maintenance

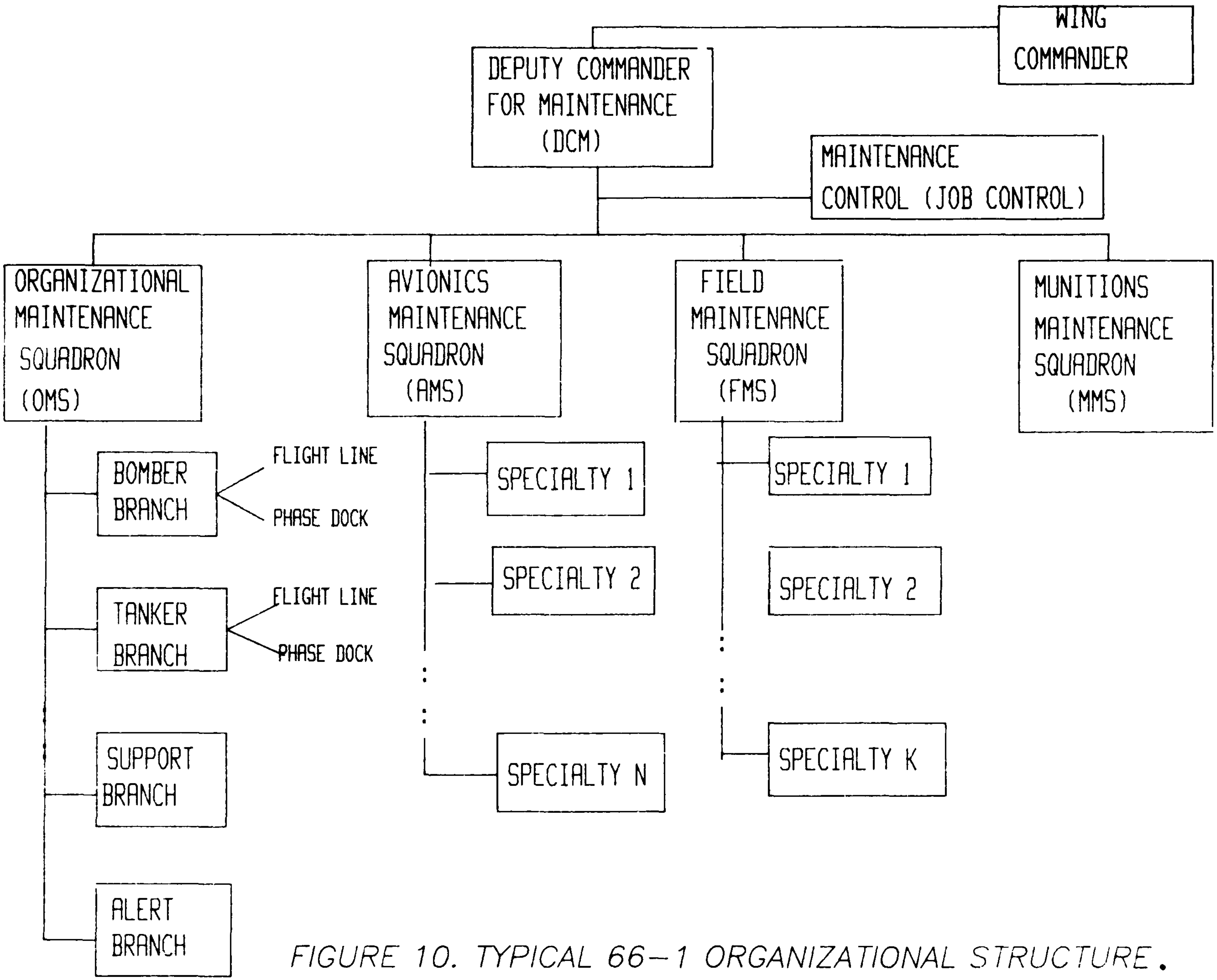

FIGURE 10. TYPICAL 66—1 ORGANIZATIONAL STRUCTURE.

(DCM). This division represents differences in task specialities (functions). The Organizational Maintenance Squadron (OMS) is charged with the task of routine maintenance related to the recovery and launching of aircraft and of routine inspections (phase docks) of the aircraft. The Avionics Maintenance Squadron (AMS) is charged with repair and maintenance of the electronic systems in the aircraft. Unless ordered to do so to an aircraft, members of this squadron are physically located in a shop of the flight line. A la portion of the work performed by AMS is on electronic equipment which can be physically removed from the aircraft for repair, but may ultimately need to be troubleshot and tested on the aircraft. The Field Maintenance Squadron (FMS) is responsible for the repair and replacement of all non-electronic systems including engines, hydraulics, electrical (not avionic) systems, sheet metal, egress systems, ground equipment such as power supplies, and so forth. The Munitions Maintenance Squadron (MMS) is responsible for maintaining all weapons systems on an aircraft. At the 66-1 installation we visited, MMS was located in the special section of the flight line where the aircraft on alert were kept. We elected not to obtain interviews in this area, hence the activities and operations of this squadron are not detailed in this report. Fortunately, MMS appears to function almost totally independently on the other squadrons, so a lack of information about it did not hinder our understanding of the remainder of the 66-1 structure.

The activities of these four squadrons are coordinated by Job Control (JC), a unit of the DCM's staff. Through its operative on the flight line called the expeditor, JC monitors and controls virtually all flight line activities including the setting of priorities and the assignment of specialists to aircraft. For example, a problem discovered on an aircraft by either the flight team or the OMS crew is reported to JC. JC will then coordinate the assignment of specialists to repair the problem. Because JC is the main contact with flight scheduling and operations, they are in a centralized position for setting work priorities.

Within each squadron, there are several branches which are organized around products. For example, in OMS there is a Bomber Branch to service bombers, a Tanker Branch to service tankers, a Support Branch to provide and service support equipment such as jacks and stands, and the Alert Branch which services aircraft on alert. Below the branch level, there may be a further subdivision into particular crews who are assigned to particular tasks such as phase dock inspections or Recovery Oriented Maintenance (ROM) teams or aircraft oriented crews (i.e., the Crew Chief concept). The exact structures used below the branch level appear to be flexible in that they may differ across or even at the same base from week to week.

The work flow in 66-1 is reasonably simple. Flying requirements are determined at the major command level and then translated into daily flying schedules as they pass through various levels of hierarchy. At the wing level (i.e., the basic flying unit which includes both maintenance and operations), monthly, weekly, and daily sortie and aircrew requirements are formulated and coordinated through a staff function reporting to the DCM and DCO. Changes in the schedule necessitated by failed equipment are all coordinated through that office. All of the aircraft in the flying unit are accounted for on the schedule such that for any given day, it is known if an aircraft is scheduled to fly, not to fly, be on alert, or be in phase dock. There is a considerable amount of communication between Job Control and scheduling regarding schedule changes which may be necessitated by non-operational aircraft.

The maintenance task, per se, is to recover, repair, inspect, and launch aircraft. In 66-1, the exact order and manner in which this task is done is all controlled by JC. OMS handles all of this except for the actual repairs and some portions of the inspections. Specialists (i.e., FMS and AMS personnel) are in contact with the aircraft as required.

The major differences in structure between 66-1 and 66-1 in ATC (Figure 11) are the placement of avionics in FMS, the elimination of AMS and MMS, and the allocation of some mainframe repair work, normally done in FMS, to the flight line. The movement of avionics and the elimination of AMS reflects the relative absence of avionics equipment from training aircraft. The same is true for armament which accounts for the absence of MMS. Moving some repairs to the flight line eliminates towing time to and from the FMS shop and, perhaps unintentionally, gives OMS management some control over the repairs. Coordination still occurs through Job Control.

Figure 12 shows the structure in 66-5. The major subdivision here is into three squadrons instead of four. The Aircraft Generation Squadron (AGS) is charged with recovery, flight line repairs, and launching of aircraft. AGS has all of the tasks of OMS, but unlike OMS, is charged with making any repairs that must be made on-board the aircraft (i.e., equipment that will not be removed for repair). Additionally, AGS has responsibility for loading and unloading weapons and maintaining all weapons related equipment (such as bomb racks). Therefore, AGS has some of the specialties that would be found only in AMS, FMS, and MMS in 66-1. The Component Repair Squadron (CRS) repairs electronic system and engines once they are removed from the aircraft. This

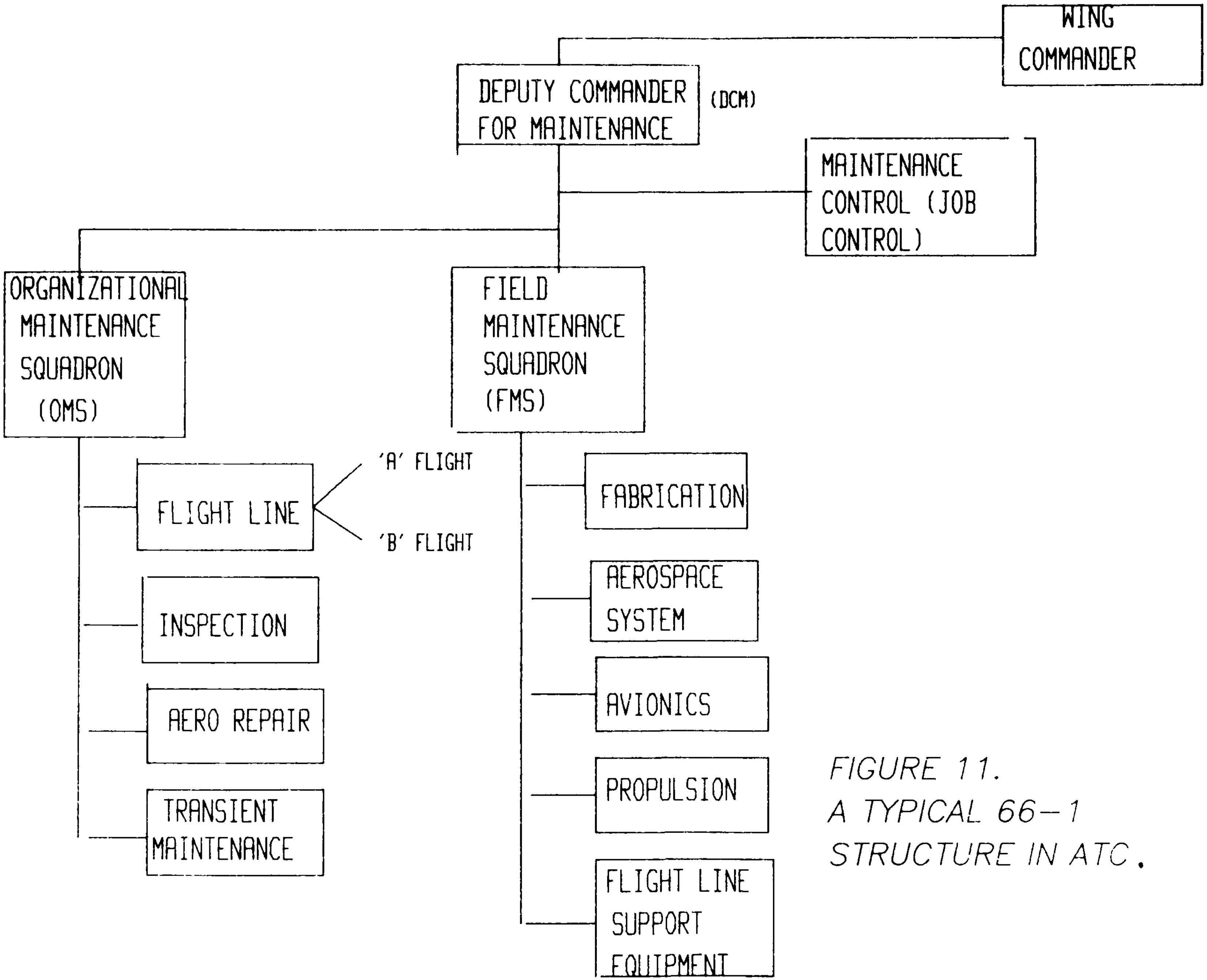

FIGURE 11.
A TYPICAL 66-1
STRUCTURE IN ATC.

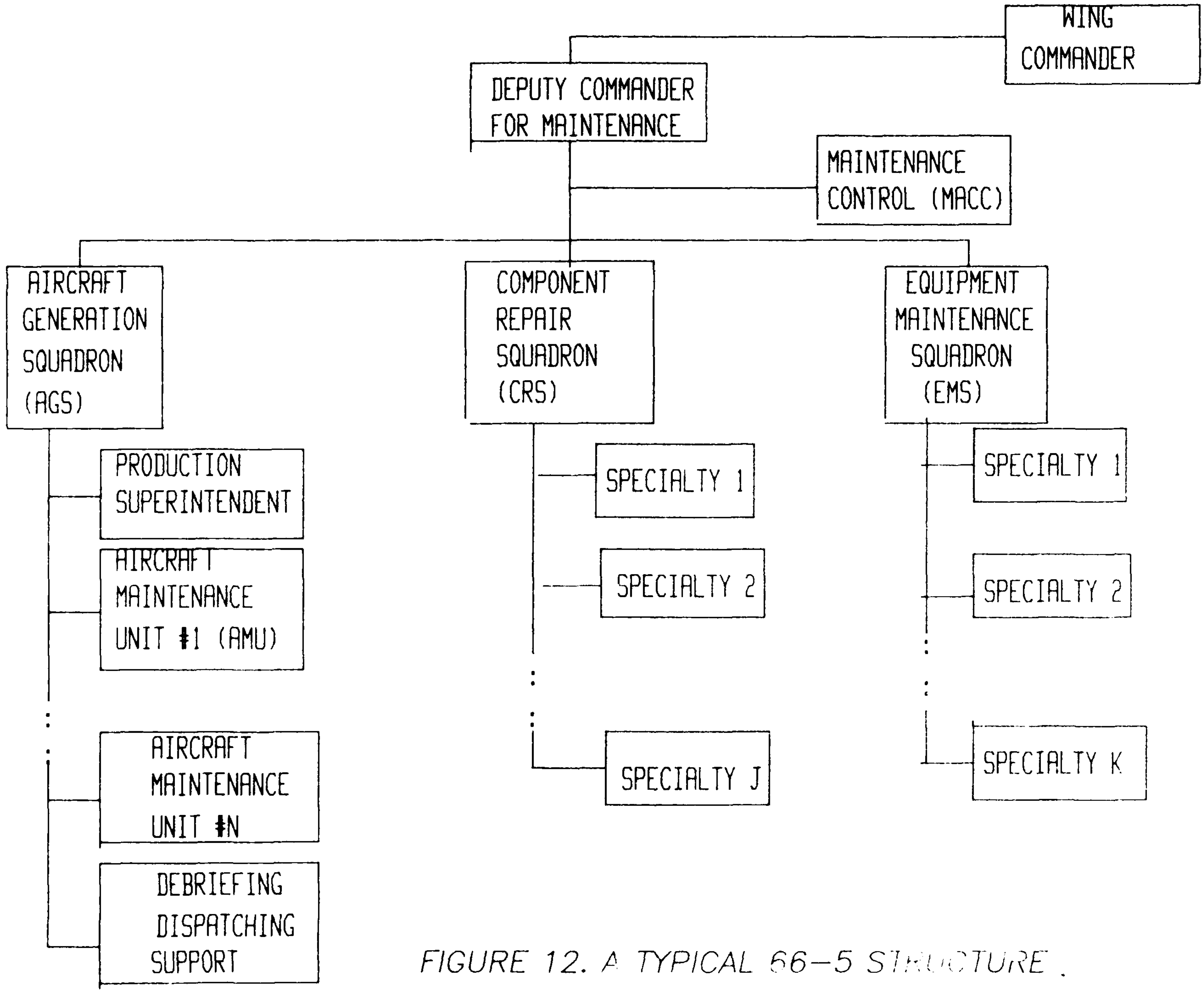

FIGURE 12. A TYPICAL 66–5 STRUCTURE.

is a job shop operation and contains some of the specialties found in AMS and FMS in 66-1. Equipment Maintenance Squadron (EMS) is charged with maintaining ground support equipment, weapons storage, and major inspections (phase docks). It contains some of the jobs found in OMS, FMS and MMS in 66-1.

Because of the intermingling of various types of specialists, the structures within each squadron are quite different from 66-1. An AGS squadron typically has branches called Aircraft Maintenance Units (AMUs) which are associated with a particular group of aircraft. Each AMU is subdivided by function into three flights: an aircraft flight, a specialist flight, and a weapons flight. The aircraft flight is equivalent to OMS in function. The specialist flight contains specialists who would reside in AMS and FMS in 66-1. The weapons flight contains specialists who would reside in MMS. A CRS contains three specialist branches: avionics, accessory, and propulsion. Within each of these reside the various specialties in that area. An EMS contains an Aerospace Ground Equipment Branch, a Maintenance Branch, a Munitions Branch and an Armament Systems Branch. Within each of these are particular task groupings.

Another difference between 66-1 and 66-5 is the structure that interrelates maintenance and operations. In 66-1, coordination is achieved through the job control function which resides on the DCM's staff outside any of the maintenance squadrons. In 66-5, the counterpart of JC is the Maintenance Activity Coordination Center (MACC). This center acts as a central clearing house for information regarding the status of aircraft. Unlike JC, MACC does not control what the maintenance squadrons do. That is controlled by the AGS shift supervisor who from his truck on the flight line controls all AGS activity. The 66-5 strucutre allows AGS to function primarily as a self-contained unit and, therefore, reduces the need for coordination and control across the three squadrons. The shift supervisor works directly from the flight schedule to insure that aircraft are ready for scheduled flights. When they are not, he or she informs MACC who, in turn, attempts to work out alternatives.

The contract structure is provided in Figure 13. Although the [illegible] is regulated by 66-1, there are deviations from 66-1 as it was described above. The major differences are in the organization of the Organizational Maintenance Squadrons and the specialty squadrons. OMS in the contract structure is subdivided into two branches depending on the aircraft maintained (i.e., T-37or T-38). The AMS is eliminated because of the small amount of avionics on the aircraft. The engine repair function is separated from FMS (in this case, Field Maintenance Branch or FMB). Support functions (i.e., post dock engine checks, towing, tires, and the wask rack) are all self contained in a branch, much as they are in EMS under 66-5. Finally, the dotted lines indicate that several specialties belonging to the FMB are "collocated" to the T-37 and T-38 branches. These include sheet metal, radio and hydraulics specialists.

Most of these differences are related to the nature of the aircraft. Engines, for example, are easily removed and replaced; this permits them to be repaired using a job shop arrangement. The most significant deviation from 66-1, however, is the collocation arrangement between the aircraft branches and FMB. This feature allows many small repairs to be ordered by the aircraft

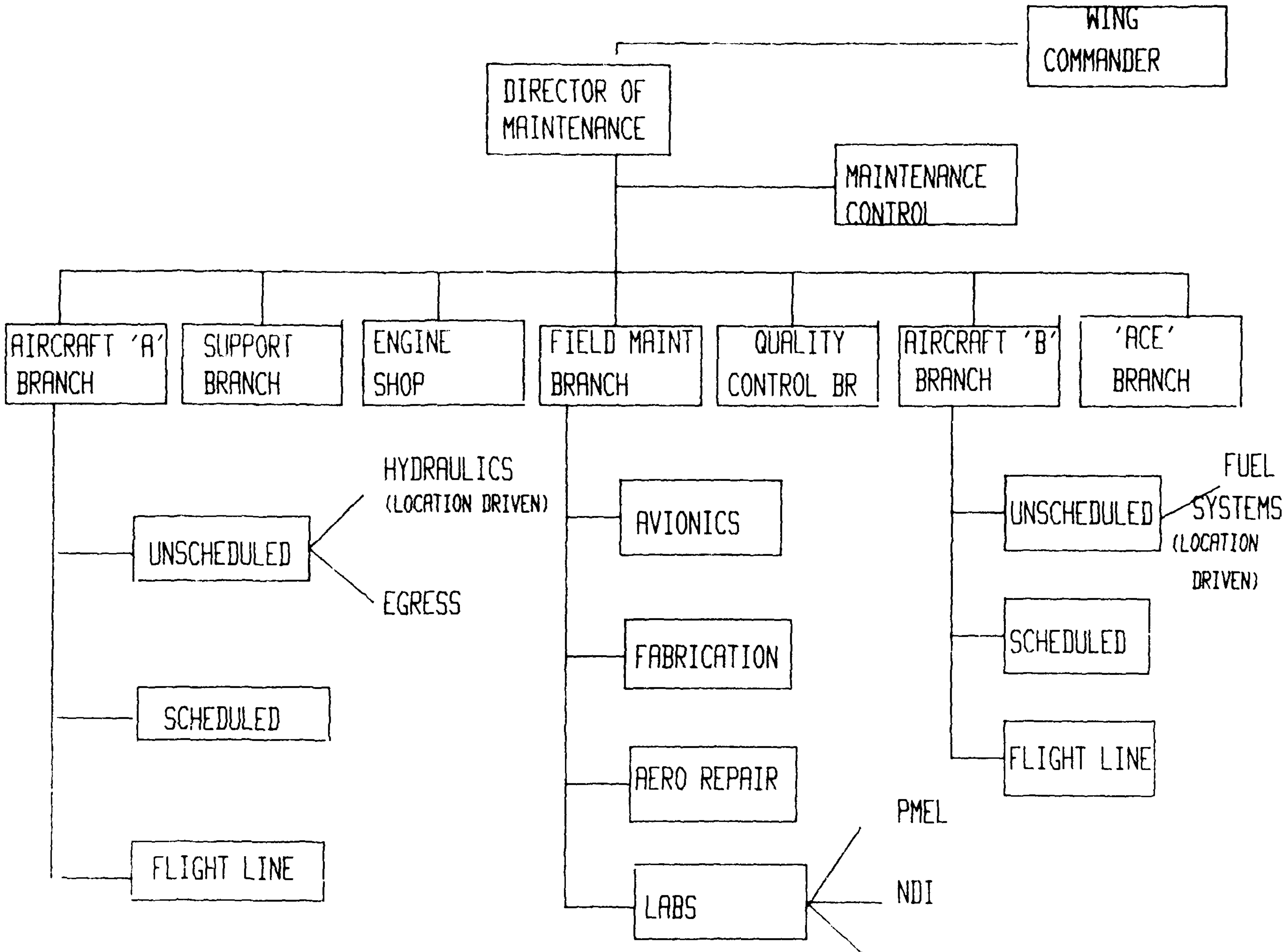

FIGURE 13. A CONTRACT STRUCTURE UNDER 66–1.

branch chiefs right on the flight line without involvement of FMB. This feature is very similar to the self-containment found in AGS. The scheduling function, the expediting function, and the relationship between maintenance and operations is the same in the contract function as it is in 66-1 in ATC.

The Structures as Adaptations

Earlier in this report, it was stated that the structure of an organizational unit could be regarded as an adaptation to its goals, environment, technology, and human resources. An abstract representation of the adaptation process would be to review it much like a simultaneous equation problem in algebra where one is seeking solutions that satisfy a number of mathematical constraints. Less abstractly, we can regard the adaptation of structures as a response of the system to a variety of demands and constraints placed on it through goals, environment, technology, and human resources concerns. As with the mathematical equation, the more stringent and the more conflicting the demands and constraints, the less likely it is that there is a solution that will satisfy the "equation." As a result, many if not most, structures are acceptable rather than optimal. They don't meet all of the requirements, but they do meet the "important" ones, those judged by the designers to be most critical.

When viewed in the context of our framework, it is clear that none of the maintenance structures is an "optimal" solution. The logic of each of the structures appears to be the product of one or two dominant considerations. Quite naturally, this leads to the structure satisfying (i.e., fitting) some of the demands and constraints but not others. What follows is a review of the structures in terms of their "adaptiveness."

66-1 and 66-5 Compared. Differences in goals and differences in environments appear to account for the differences between these forms. As noted earlier, there are major differences between SAC and TAC in terms of wartime missions and in peacetime sortie rates. Similarly, there are differences in wartime environments. The SAC structure, 66-1, has several features that appear to be adaptations to its goals and environment. First, 66-1 is essentially an instance of organization "by function." This means that the basic unit of organization, in this case the squadron, is assembled according to a task specialty (e.g., avionics, munitions, mainframe and engine repair, etc). In functional organizations, control is obtained through an office located at a level in the hierarchy above those units which need to be coordinated. In the case of 66-1, Job Control carries the power of the Deputy Commander for Maintenance, the position at the top of the maintenance hierarchy on an air base.

Functional structures are most commonly found in organizations with single product lines and low environmental complexity. As the diversity of products or environments increase, however, such structures are less commonly used. In the case of SAC, the operational environment (i.e., base of operations) is relatively fixed and constant. Both in peace and war, maintenance will be performed in similar environments. There is only a small amount of diversity among the missions flown by SAC, most of which are long range bombing runs which can be, to a great extent, programmed and planned in advance. All of these factors combine to support the logic of functional specialization and centralized control.

Specialization makes sense when an organization is going to be performing a fixed array of tasks on a continuing basis. In such situations, it is generally beneficial to specialize around those tasks. The low diversity in environment and types of mission at 66-1 installations coupled with the amount of time between sorties for an aircraft permit considerable task specialization.

Control can be centralized in SAC context because of the time between sorties (for a given aircraft) and the feasibility of planning. The main reason for decentralization is to put decisions closer to the source of information. This has three effects: to increase response time, to reduce the possibility of information distortion through miscommunication, and to reduce the load on communication channels. When there is sufficient time to communicate and when the information to be communicated is fairly "standard," as it tends to be in stable, low complexity situations such as the 66-1 context, centralization is made more feasible and tends to be the preferred mode for many top managers.

The 66-5 structure more closely resembles a hybrid organization. In AGS, a number of functional specialties are "wrapped around" the product, a particular type of aircraft. The Aircraft Maintenance Unit (AMU) is a self contained structure which can perform most maintenance tasks without going outside of the unit. So instead of being organized around a class of task specialties, as is 66-1, the AMU is designed with a capability to perform many tasks for a particular product. AGS has little need to coordinate with CRS and EMS except in exceptional circumstances. This is in contrast to the relationship between the squadrons in 66-1 where constant coordination is necessary.

The wartime mission appears to be the major rationale for 66-5. The self-containment of most relevant specialties in AGSs permits easy deployment of an AMU with minimal operational disruption. The advantage to TAC is the ability to deploy selected groups of aircraft, flying personnel, and maintenance personnel (i.e., an AMU) at will with little or no need to reorganize.

A possible secondary rationale for self-containment in the AMU is cross utilization of personnel to accomodate the high sortie rate flown by TAC. With many aircraft flying three or four sorties per day, there is little time for towing, personnel assignment and reassignment, or the other vestiges of task specialization. By having all specialties and the main coordination function (i.e., the shift supervisor) located on the flight line, most repairs can be made more rapidly than would be the case in 66-1.

The results of the interviews with maintenance personnel support the interpretation of the two structures as adaptations to different goals. Typical responses to the question of why the 66-1 structure was used included:

> "...provides a common core of expertise. People working together know the same things."

> "...give clear lines of responsibility. Most problems due to age of aircraft. Even scheduling problems are not because of scheduling (structure)... they are age problems."

> "...the feasibility of POMO (66-5) in TAC is because the aircraft are new and small. The size and complexity of long range bombers and tankers create problems with the use of teams (e.g., AMU's). Teams would take many more people... (aircraft) would not be as safe."

> "The system reflects a desire to standardize. The complexity (of the aircraft) requires standardization."

Typical responses to the same question for 66-5 were:

> "Mobilization is the major reason for 66-5."

> "It is a question of going away in pieces, not fighting from where you are. Our reason for being is to deploy, probably to different places. We can go from semi-autonomous units to fully autonomous units quickly and efficiently."

"...intactness, to move as an intact unit. My experience is that it (intactness) makes a difference."

"66-5 is more realistic of how we will operate in war."

"Modeled after Israeli Air Force. Israeli's are more concerned with ends...we (USAF) are more concerned with means. That's because of the differences between war and peace environments."

These responses support the notion that the structures are adaptations to differences in the goal and environment contexts of the two structures.

The interviews also suggested several areas in which the two structures were less well adapted to their contexts. The most obvious of these concerned how the two structures dealt with the technological and human resource issues. There was a strong feeling, especially among specialists (i.e., AMS, FMS, CRS and some AGS personnel) that the AMU structure worked against the development and retention of critical specialist skills. The following excerpts from the interviews illustrate the problem:

"(AMU) creates too many generalists, makes crew chiefs out of specialists. 66-1 is grounded in Air Force Specialty Code, good for training and testing."

"Cross Utilization Training (CUT-Training) goes one way... tends to make crew chiefs out of specialists, but does not make specialists out of crew chiefs."

"AMU's are more thinly manned with specialists."

"...creates friction between AMU specialists and (those in the) shops."

"66-5 creates super-specialties which cannot cross utilize. People gravitate toward either the flight line (AMU) or the shop (CRS)...they cannot be cross utilized because they develop different capabilities."

"When specialists move to 66-1 from 66-5, they need to be retrained...they have lost critical skills."

"66-5 flies an inferior quality aircraft. The quality of maintenance is not as high."

"...keeps splitting people up until at the shift level may have one inexperienced person. No one to train them."

These comments reflect what can occur in a self-contained structure. In order to avoid duplication of effort, individuals are "spread thinner" and may be expected to perform multiple duties. In this case, specialists are asked to perform services that are outside their specialties. In the long run, this may lead to a decrease in the speed and quality of work performed by the specialists, particularly when the specialists' task is complex as it is with technologically sophisticated aircraft. It should be noted that these types of comments came mostly from specialists or individuals who had to manage specialists. Many of these individuals had experience under both structures. Individuals who were "raised" in 66-5 did not make these kinds of statements and generally tended to be more satisfied with the structure.

Further, because of voluntary and forced turnover, maintenance squadrons are faced with a substantial burden of on-the-job training. Such training is feasible only when there is a sufficient number of trainers and some slack time for training to occur. This does not seem to be the case in 66-5. Skilled people are spread very thin, and when they are available, are used to perform required maintenance rather than to train others. In 66-1, because specialized skills are housed in functionally separate units, it is much easier to absorb unskilled personnel and train them without disrupting the work flow.

A second, less mentioned, potential maladaptation concerns the management of human resources in OMS (66-1). This had to do with the relatively bland nature of the job for lower level personnel and the lack of significant control by some of the supervisory personnel. The task of the OMS person is sometimes described as that of a "gas station attendant." This is in contrast to the more "craft oriented" or technical tasks in AMS and FMS. At the supervisory level, some respondents spoke of Job Control as a kind of "big brother" who, when push came to shove, would retain full control of the flight line. Some representative comments on this issue were:

"OMS morale is low...not much opportunity to learn."

"The problem with 66-1 is responsibility without resources or control."

"Compared to 66-5, less personal ownership of aircraft."

Several individuals who had worked under 66-1 but were now in 66-5 made the following observations:

"The thing I like best is that decisions are made on the spot, not by someone off in a dark room who only knows what he/she is told."

"66-1 is like going back. I like controlling my own destiny, MACC just being for coordination. CUT training helps set dual use from people."

"In 66-5, responsibility is associated with the person doing the job."

These comments suggest that, at least for supervisors and possibly for very experienced specialists, the motivational climate of 66-5 is preferable to 66-1.

Most of the other types of comments made during the interviews about the structures concerned how they were managed rather than aspects of the structures. Several comments were made about Recovery Oriented Maintenance in 66-1. This is a team concept which, because of manpower scarcity, moves away from the crew chief concept. Several respondents working under this system felt that it undermined any sense of product (aircraft) identity they might have had. While perhaps necessary in the context of that organization, the use of these teams seemed to further intensify the problem noted by the preceding quotations.

66-1 (ATC) and Contract Compared. This comparison is particularly interesting because the only contextual factor that differs between the two is human resources. In 66-1 (ATC), most of the maintenance personnel are military. In the contract setting, all personnel are civilian.

An examination of the structure used for these settings indicates few differences. The biggest difference is that the contract structure creates separate branches reporting directly to the Director of Maintenance (DCM equivalent) for engine repairs, transient maintenance and support (i.e., ground equipment). These are found within squadrons in 66-1 (ATC). Some structural repairs are also assigned differently. In contract, more are performed in field maintenance. In 66-1 (ATC), it is in OMS. These differences really only affect reporting relationships.

The most important difference between the two structures does not appear on the organizational charts. This concerns coordination. In contract, the heads of each aircraft branch, who are the equivalent of an OMS superintendent, is a major coordinator. Ultimately, he or she can decide whether or not a scheduled aircraft flies. These decisions are made on the flight line rather than in JC. In 66-1 (ATC), these decisions are made by JC. The biggest reason for this is the treatment of the Airplane Branch as a kind of profit center. Ultimately, it is the performance of this unit that determines whether or not the contractor operates within the bounds of the contract. The job of Branch Manager in the contract structure is a lifetime occupation, not a three year tour. Several statements from the contract interviews are pertinent to this point:

"Because of the experience level of our workers, job control really has more of a coordinating function."

"Our watchword is autonomy. We have a very high experience level here."

"For us flexibility is the key...flexibility and autonomy. We have more than other maintenance operations."

To create this flexibility in the contract arrangement, there are several FMB people permanently assigned to the Airplane Branch hangers which, de facto, put that branch manager in charge of scheduling and assigning their activities. The Airplane Branch in the contract arrangement resembles an AMU in 66-5. The main reason is to provide speed and flexibility. In contrast, 66-1 (ATC) is basically a standard 66-1 operation. The only important distinction is the placement of Aero Repair in OMS to facilitate flight line repairs. Job Control is the major coordinating device.

Both the contract and the 66-1 arrangements differ from the other structures because of the nature of the aircraft (technology) and the sortie rate (goal) flown. The placement of specialists on the flight line formally through Aero Repair in 66-1 (ATC) and informally through collocation in contract are responses to the need for speed. The aircraft are comparatively simple and the utilization rate is high. Repairs may be simple, but they must be made quickly. Both of these arrangements allow this. Similarly, both arrangements have placed avionics in FMS because of the comparitively small amount of such equipment on training aircraft. This creates no problems for the contract arrangement, but some major problems for the 66-1 (ATC) arrangement since it is dealing with military manpower. The problem is that the AFSC of the people who perform avionics maintenance in ATC are the same as those in other major commands. The job expectations of these people appear not to be met when avionics is placed in FMS. The following is a representative quote from one such specialist:

> "The electronics people are very bright and have their own procedures and ways of doing things, but FMS procedures are imposed on them. Thus, there is a lack of fit which makes the avionics supervisors unhappy. They have to fight FMS procedures to get the job done."

This is a particularly cogent illustration of the adaptation framework. The difficulty exists for the military installation because it must operate within a larger context that controls the allocation and training of manpower. The contract arrangement need not face this constraint.

Summary

This section has used the Galbraith framework to evaluate the extent to which the various organizational structures used for aircraft maintenance in the Air Force are adapted to their respective contexts. The analysis suggested that differences in goals and environments appeared to account for the differences between the 66-1 and 66-5 structures. The key issues involved the deployment requirement and high sortie rate in 66-5 contexts. The framework also helped to identify two areas in which the two structures seemed to be less well adapted. In particular, 66-5 appeared to lack the conditions necessary for the development and maintenance of specialty skills. This is a real problem in the human resource environment created within the Air Force. 66-1 appeared not to provide a sufficiently rich task environment for OMS personnel.

An analysis of 66-1 (ATC) and a contract arrangement indicated that both structures are appropriate adaptations to their contexts. The only serious lack of fit seemed to be the placement of avionics specialists in FMS in the 66-1 (ATC) arrangement.

Systems and Development Acquisition

Pre-Matrix

Acquisition offices within the Air Force were traditionally organized on a program basis (Thurber, 1978). Divisions within the Air Force Systems Command (AFSC) did not reorganize into matrix structures until 1976. Prior to that time, the program structure emphasized the assignment of all necessary functional personnel directly to Systems Program Offices (SPOs). Each SPO typically had functional specialists assigned directly to the program, and functional chiefs had little responsibility or control over professional's working within the SPO. Program managers were responsible for virtually all activities and personnel required to accomplish their program. Small functional offices (procurement, production/manufacturing, comptroller) did exist, but they acted only as backup support to the program offices. Engineering provided some consulting service to the SPOs in specialized fields.

During the late 1960's and early 1970's, changes on the national level were felt within the product divisions of ASFC. Many older, mature programs were being managed within ASFC, and many new programs came into being. Foreign military sales also became an auxiliary component of most programs. The growth of new programs created a manpower crunch. Thurber (1978) reported that in the face of increasing program requirements, the Aeronautical Systems Division (ASD) experienced a net loss of some 500 persons. The manpower shortage combined with the need to maintain some form of program structure led to consideration of the matrix. Moreover, ASD managers were concerned about the lack of technical cross-fertilization between programs, insufficient technical training and development for professionals in the SPOs, and poor response to workload shifts both within and between SPOs. An example of the pre-matrix structure is in Figure 14. Each SPO was a self-contained unit. The centralized functional staff agencies were typically small and served only in an advisory capacity. They had no official responsibility over professional employees located within the SPOs.

Matrix Implementation

The matrix structure was implemented in 1976, and caused a number of changes internal to the AFSC divisions. However, no change was more significant than the new reporting relationships for professional personnel.

> Perhaps the most dramatic feature of the reorganization was the personnel accountability transfer of functional specialists (military and civilian)from the program offices to the respective functional deputates. This meant that, for formal personnel purposes, such specialists were no longer directly assigned to the program offices in which they actually worked, but were instead assigned to "home offices" within their respective functional organizations. The immediate effect of this change was to significantly reduce the apparent size of the SPOs, while at the same time to considerably increase the size of the formerly small functional "staff" organization. For example, the deputy for procurement and manufacturing increased in size from an authorized strength of 400 prior to matrix implementation to a total strength of more than 900 following it (Thurber, 1978 p. 49).

A simplified version of a hypothetical matrix structure used in AFSC product divisions is in Figure 15. The horizontal lines indicate that functional offices have responsibility for their specialists located within the SPO. The operation of the matrix involves both a "senior collocate" and subordinate professional employees. The senior collocate is physically located in the SPO and reports to both the SPO director and to the functional director. His or her subordinates are assigned to specific projects within the

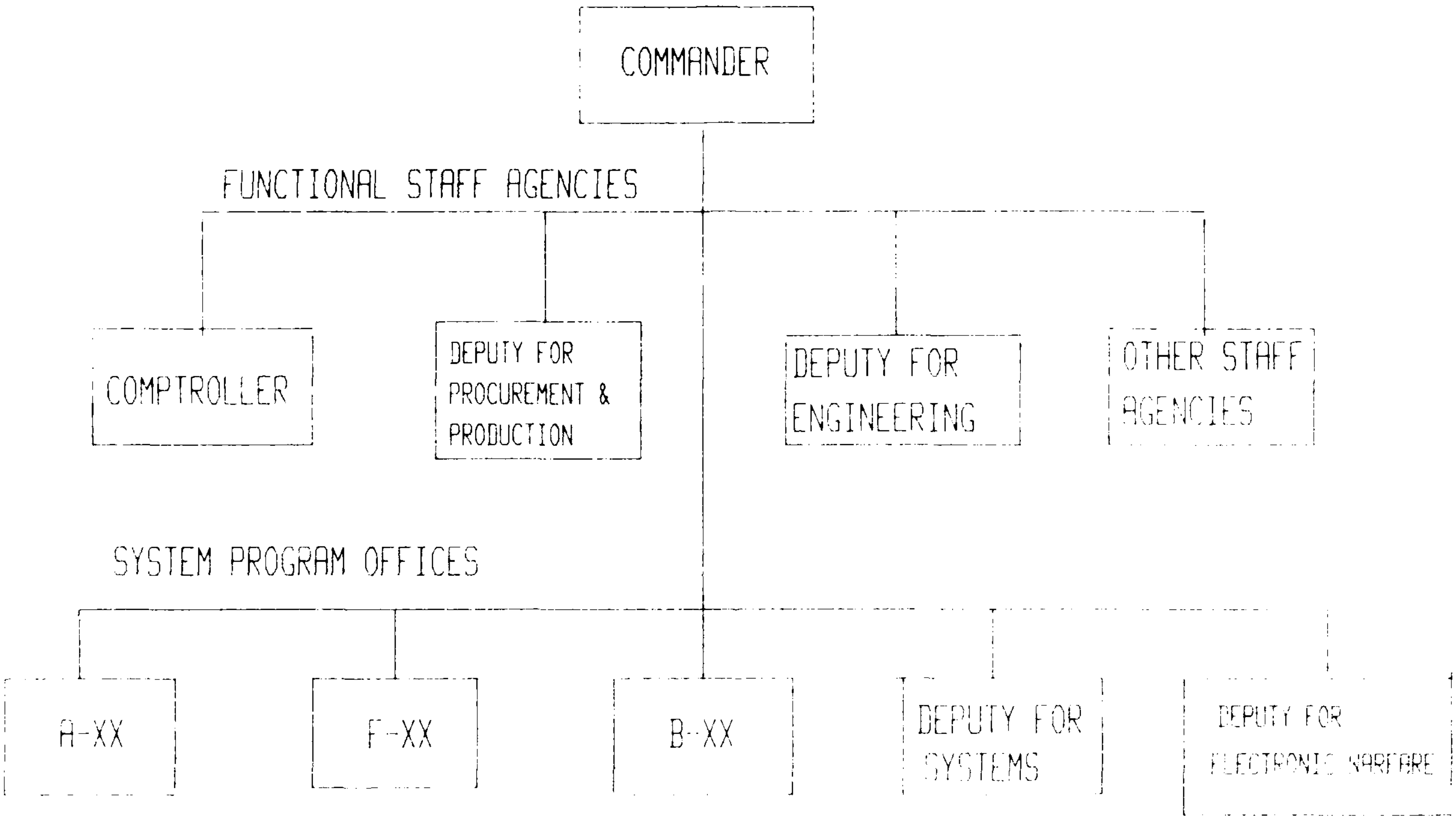

FIGURE 14. PRE-MATRIX PROGRAM STRUCTURE (SIMPLIFIED).

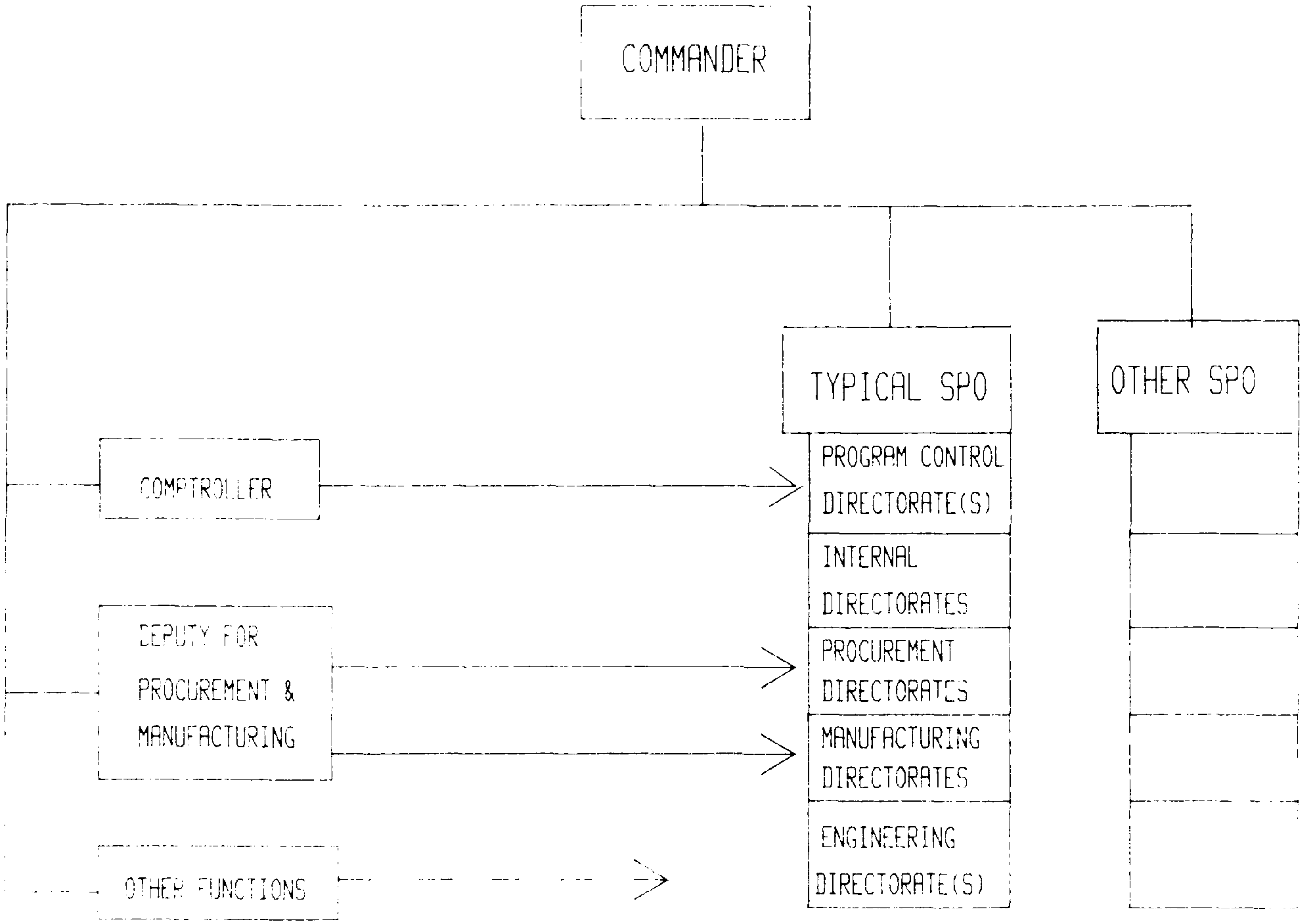

FIGURE 15. HYPOTHETICAL MATRIX STRUCTURE (SIMPLIFIED).

SPO. The subordinates may also have two bosses, reporting both to the senior colleague and to the project managers to whom they are assigned. The important difference between the matrix structure and pre-matrix program structure is that functional directors were now actively involved in the management of professional specialists.

Under the matrix structure, program offices were still responsible for the accomplishment of program goals. They were expected to obtain resources, to coordinate functional inputs to the program, and to achieve schedule objectives. However, they now did so without having formal authority over functional specialists.

The change to matrix had impact in the functional offices. The functional managers now had direct responsibility for the specialist personnel assigned to all programs. The functional office was expected to recruit personnel, provide mechanisms for career development, interpret program needs, set priorities for reassignment of personnel, development standard procedures, keep all personnel records, and provide backup expertise to specialists physically located within the SPOs.

Mature Matrix

With hindsight, the original program structure and the matrix structure that followed were appropriate for the context of AFSC product divisions. The original use of a program structure and the change to a matrix structure was consistent with the theoretical discussion earlier in this report. AFSC divisions faced an uncertain environment. A division might be faced with adding two or three new programs in a single year. Moreover, Congressional and Headquarters, Air Force decisions could shift funding and program priorities at any time. The technology of weapon system acquisition and development was also difficult. The product is an idea. The task of research and development is to create a tangible product from an abstract concept. This task is non-routine and unpredictable compared to the tangible, well understood acitvities of flying and maintaining aircraft typical of other commands. The program and matrix structures used in AFSC were appropriate to AFSC's environment and technology.

The original goal within AFSC was program effectiveness. The program structure, which groups all resources by program and gives formal authority to program directors, is suited to this goal. By the mid-1970's, however, a second primary goal became apparent--make better use of scarce personnel resources. Dual goals, in some respects contradictory to one another, indicates that a matrix form of organization was appropriate. The program side of the matrix had the authority and responsibility for program effectiveness. The functional side of the matrix was responsible for the efficient use of professional specialists.

In summary, the Air Force System Command moved in the right direction by adopting a matrix structure in its product divisions. The unique circumstances of AFSC also mean that matrix structures probably would not work in Air Force commands that are characterized by a more certain environment, a more routine technology, and by a single goal.

Matrix Successes

Our interviews with personnel throughout AFSC included questions about how the matrix structure was working for them. Did they see any advantages to the matrix? Their responses indicate that the matrix structure was suceeding in several ways compared to the previous program structure. The reported strengths of the matrix organization are as follows:

1. Limited personnel resources are stretched further. The matrix utilizes experts on a part-time basis across several projects. This is a more efficient use of personnel than having experts assigned full-time to each program.

2. The professional specialists have a home base. The home base provides a vehicle through which senior collocates can meet with other senior collocates to share ideas and acquire feedback on how they are doing. The home base also provides a pool of backup expertise to help collocates with unusual problems. Specialists now can identify with their specialty rather than with the program office. The functional office usually keeps personnel records, and is responsible for performance appraisals, promotions, and training.

3. Functional tasks are uniformly executed across program offices. The authority given to the functional offices provides a mechanism to coordinate the activities of each function (e.g., controller, engineering) across SPOs. The use of standard procedures provides a basis of comparison and makes it easier for personnel to shift between programs.

4. Personnel can be reallocated. The matrix provides a mechanism to shift scarce personnel across programs as priorities and workloads change. The functional deputate has the authority to allocate people. The functional chiefs can monitor the workloads and reassign personnel as needed to balance contributions across SPOs. In the previous program structure, no reallocation procedure existed, which reduced the ability of the division to respond to changes in funding and priorities.

5. Reduced administrative loads for program offices. A large volume of paperwork was transferred to functional home offices. The program managers can concentrate on coordinating projects and achieving deadlines.Personnel records, performance appraisals, and other records are completed in the functional offices.

6. Program can draw upon expertise from many fields. The functional offices can provide experts to the programs on a full time basis, part-time basis, or strictly in a consulting role. For smaller SPOs especially, the ability to draw upon part-time and consulting expertise is important because projects are not large enough to afford full-time specialists. The pooling of expertise can lead to a more effective project.

7. Broad professional development for experts. Technical experts are exposed to diverse projects over their careers. They also work and coordinate with specialists from other fields during the course of any project. Functional experts are exposed to other specialties and become broader and well-rounded in the process. Their own discipline is not the controlling force in any project outcome, but must be integrated with other disciplines for successful project development.

Matrix Problems

Although the problems associated with implementation of the matrix are now in the past, the matrix form of organization carries certain costs and dissatisfactions for employees. Despite the maturity of the matrix, employees report a number of difficulties. Although the matrix structure will never satisfy all parties, some problems were reported by several respondents:

1. Project managers seem overloaded. Project managers are expected to brief visiting generals and congressmen, coordinate a number of specialists and contractors, and resolve most problems that arise. Most respondents asserted that the success of a program depends upon the program manager. When project managers are spread so thin, the primary goal of completing the project can get lost.

2. Program manager turnover reduces continuity and corporate memory for long-term projects. Project management often seems to be used as a training ground for program managers, who then move on. This process is good for program managers because they receive excellent managerial experience and exposure. But it can be bad for the project because the project manager is not ultimately responsible for meeting schedules and project completion.

3. The structure is not people-efficient with respect to administrative overhead. New positions were created in the functional offices to run the matrix. Moreover, the matrix requires continuous coordination and problem resolution. The matrix requires both extra time from project and functional personnel and extra people to manage the coordination and reallocation of specialists. The savings the matrix provides by reducing the number of functional specialists is offset by greater costs in administrative personnel.

4. Two-boss management can create confusion and uncertainty for both the boss and subordinates. A number of people mentioned that having two bosses is difficult. There is uncertainty with respect to how the two bosses will influence activities and career. Bosses are also uncertain about how to manage part-time employees who have other commitments.

5. Project managers cannot reward or punish team members easily. A lazy specialist can hide behind the matrix, using it to go slow by saying he or she is actually working on other tasks. Program managers do not have direct control over team members with respect to promotions, salary, or performance appraisal.

6. Specialists located in the functional offices feel they are not recognized and do not have clout within the system. They believe they are second-class citizens and that program management gets the promotions, awards, and raises for people in the SPOs. The career progress of engineers, for example, is believed to be slower if they stay within the engineering function. They perceive a need to become program managers in order to improve themselves.

7. The current matrix structure works better for large SPOs than for small SPOs. Large SPOs often have personnel assigned full-time. Projects in the basket SPOs have people assigned part-time. Often, these people neither identify with nor feel committed to the project to which they are assigned. Program managers have no way to control these people directly.

8. Insufficient communication exists between the functional and program side of the matrix. Program managers, for example, provide little input to performance appraisals that are filled out by functional managers. Functional managers, on the other hand, feel they often do not have adequate information upon which to base performance evaluations. Program managers are unsatisfied because they perceive little formal influence, yet they are not sending informal communications to the functional managers. Additional communication between the two sides of the matrix could reduce dissatisfaction.

9. Engineers who are assigned to a large SPO may be lost to other SPOs for their career. Some SPOs are large enough to transfer engineers among their own projects, and the specialist may lose engineering variety and depth. They do not return to the functional home base for retooling and retraining. They may end up doing generalist work for the program managers such as designing view-graphs for presentation.

10. Both sides of the matrix feel frustration about having more responsibility than authority. This is an interesting characteristic of the matrix because both sides must share authority over subordinates. The lack of perceived authority cannot be resolved completely, but could be modified through additional communication between functional and program offices.

Two Key Issues

The interviews with matrix personnel about successes and problems can be summarized in two issues. An effective matrix, as used witnin AFSC, should be arranged to support the program manager and to resolve the dilemma of control.

Program Manager Impact. Respondents repeatedly told us that an effective program was determined by the ability of the project team to meet schedules and milestones. They also said that the single most important cause of a successful program was the program manager. The program manager is the most important cog in the AFSC wheel.

Yet as currently organized, the impact of program managers often seems diffused. Program managers may have to spend time briefing senior personnel rather than coordinating the project. And program manager turnover is frequent. Project managers typically leave after three to four years, which is less than the life of the project. The most important cause of project effectiveness, the project manager position, is characterized by attention to peripheral activities and frequent turnover. Organizational changes that could maintain program manager accountability for completion of the project and encourage the program manager to focus exclusively on coordination activities would facilitate the completion of AFSC weapons systems, weapons, and communications.

The Control Dilemma. The second issue is the dilemma of control. Project managers have substantial influence within the division but do not have formal, paper control over team specialists. On the other hand, functional directors have formal, paper control over specialists but do not have sufficient overall influence to direct promotions and career progress. Overall authority and day-to-day control are not in alignment for either program or functional managers. The dilemma of control affects basket SPOs more so than large SPOs, although the problem exists in each.

The dilemma could possibly be reduced through improved lateral communications between the program and functional sides of the matrix. The program manager could be given more say about day-to-day specialist activities as influenced through performance appraisal and salary increases. Functional managers could have input into career decisions and awards. Increased communication between functional and program managers might resolve these issues. These issues could also be resolved to some extent by having both the project manager and the functional manager complete performance appraisal forms for inclusion in the specialist's personnel file.

Summary

The Air Force Systems Command has evolved from a program structure to a matrix structure. The matrix structure is the correct structure because it is compatible with environmental changes, non-routine technology, and goals that emphasize both program effectiveness and the efficient utilization of scarce personnel resources. The matrix has matured over the last several years in AFSC project divisions. It is the source of many improvements over the previous program structure.

However, a few problems remain. Additional adjustments to bring about greater focus and responsibility for program managers and to resolve the dilemma of control between program and functional managers could bring the matrix into even better alignment with the program development task.

CHAPTER FOUR

SUMMARY AND RECOMMENDATIONS

Importance of the Study

We have considered several issues in this report regarding organization structure. Included in this report were a statement about the importance of organizational structure, theoretical models for structural variations and alternatives, a methodology which can be used to study structural issues, and an application of both methodology and theory to specific Air Force situations (maintenance and systems acquisition). The maintenance functional area was chosen due to its central importance to the Air Force mission. The acquisition area was chosen due to its use of relative "nontraditional" structures. On the surface, these two seem very unrelated. But the presence of organizations such as the Air Force Acquisitions Logistics Division (AFALD) links the two together. The AFALD was established in 1976 with the general purpose of influencing the design of a system so the system is available, reliable, affordable, and maintainable. This combination of functional elements provides a very relevant and distinctive breadth to the present study.

The study provides several new dimensions. First, it examines organization structure on a general scope. It is certainly true that specific studies of both maintenance and systems acquisition have been done previously. Some of these are comparative (i.e., centralized vs decentralized maintenance). We, however, are taking the analysis one step further. This effort, is the first we are aware of that looks at difference types of structures within the same context. This is a broad based study that more generally examines the topic of structure within a model context.

Second, the report provides a specific methodology which may be used to study additional functional area groups. The use of a structured interview format illustrates the optimum in flexibility and comparability across bases and locations. Certainly, the procedure is more time consuming than other forms of data gathering, but this use forms a clear, rich basis for some current conclusions, and points to directions for future work in a crucial area.

Finally, the report provides a combination of theory and application. The presentation of the two theoretical models followed by their descriptive application in Air Force units provides the opportunity not only to become more aware of organizational structure theory but to see how the theory may be applied and used in future organizational structure decisions.

For example, consider the Galbraith model discussed earlier consisting of four paremeters (environment, technology, goals, and human resources) in addition to structure. Use of this model provides a path to follow for commanders interested in designing or changing a structure. The first issue is to decide how important each of these parameters is. We have already given the example of a structure (decentralized maintenance) created to provide the maximum flexibility of being prepared for an immediate combat role any place in the world. Here, the goals issue is paramount. The environment is uncertain and human resources are variable in terms of availability and range of experience. The result is a technology which needs to remain as simple as possible to meet the requirement of priority flightline maintenance. When technology becomes very complex, this approach will encounter problems.

Similarly, the model can be used as a predictor. During our work, we heard much about new and advanced technology, in particular, modularized technologies. What might the impact of such technology be on both centralized and decentralized forms of maintenance? Given this technology, how many people will be needed? What kind of training will they need to have? Will there be more need for specialists? One very likely possibility is the need for two tiers of specialists: those on the flight line and those in the shops. This might require separate AFSCs, training packages, and skill testing, but the result could be a more adaptable force.

This work does not answer all questions, but some answers do seem possible. These questions and their answers (based on data gathered during the study) provide a concise summary of the research findings.

Summary Questions and Answers

One purpose of the study was to answer some basic questions about Air Force organizational structures. For convenience, the questions are grouped under three categories: general Air Force organizational structural issues, informal structures and interface problems, and organizing for peace vs. war.

General Air Force Organizational Structure Issues

Is there one ideal structure for the Air Force? There isn't one "overall" ideal structure. The structure used by a given organization must be goal, technology, resource, and environment related. Since there are many different goals or missions in the Air Force, there isn't any one structure that would apply to all situations.

What are the various structures that exist in the Air Force? This study was limited in scope and, therefore, didn't cover all possible structures. We did, however, see examples of matrix structures, hybrid structures (primarily decentralized maintenance), and functional structures (primarily centralized maintenance). We did not see any example of a pure program structure, although matrix has elements of this.

Is there an appropriate structure for each type of Air Force mission? Yes, we believe there is a best structure for each organization. By and large, the structures we studied fit well, although there were occasionally some minor problems. It is important, however, not to fit structure across missions, but to fit the structure to the mission. A structure should help people do the job; at a minimum, structure should not be a burden or a barrier to job performance.

Are current Air Force structures adequate adaptations to their mission, technological, and human demands constraints? Yes, the structures we studied fit well. The matrix approach seems ideal to the comparatively fluid research and development environment. Contract maintenance is an immense advantage for maintenance of training aircraft in a central location. Decentralized maintenance is well adapted to a mobilization environment, and centralized maintenance is well suited to strategic needs and a more generalizable approach to maintenance for training aircraft.

What are advantages/disadvantages to decentralized vs. centralized maintenance and what is optimum in respect to the two? In a nut shell, decentralized maintenance provides for rapid deployment and the potential for more sorties with minimum down time at a possible cost of not developing specialized maintenance skills. Centralized maintenance allows for quality maintenance and the development of specialization at the potential cost of slower turn around time and possible flight line coordination problems. As to what is optimum, it depends again on mission. For a very stable environment, centralized maintenance seems a better approach. For a very mobilization oriented environment, the decentralized approach seems to have several advantages.

What about contract arrangements for maintenance organizations? Contract arrangements have distinct advantages in certain situations. In fact, the contract arrangement in this report was a perfect example of adapting structure to mission. In this situation, the people showed longer tenure than in military organizations and a higher level of technical knowledge and on-the-job experience. This leads to a high quality product using fewer people. The cost is in limited goal diversity or in loss of flexibility. Structural adaptations cannot be easily generalized, and mobilization would be difficult.

What are the advantages/disadvantages to the matrix structure compared to the previous program structure used in research and development? The advantages/disadvantages of both types of structure are detailed in Chapter One. Basically, matrix advantages include encouraging more efficient use of human resources, providing a functional "home" for specialists, giving the ability to respond to competing pressures simultaneously, and encouraging extensive communication and coordination. Disadvantages center on program management support and control. On the program side, this structure is suited to fast change, conflict across functions is minimized, and organizational goals take precedence over limited functional goals. Disadvantages center duplication of resources across units and loss of in-depth competence in specialization.

Can a matrix structure be applied to maintenance organizations to better use scarce technical personnel? No, not across the board. Matrix may use scarce resources better than the program structure but not better than the functional structure. Since Air Force maintenance organizations already have strong functional orientations, it seems unlikely improvement would result.

At what hierarchical level should the matrix cut off and the organization become line and staff? There is no set level, but it can occur from the top of the organization down to any relevant unit. Generally, matrix best exists at only one level in the organization. This level is determined by the convergence of two factors: where coordination is needed, and where the matrix "boss" has autonomy and is relatively protected from the outside environment.

Informal Structure and Interface Problems

Is informal influence a problem, and if so, how can it be solved? In our data, we found informal influence was nearly always present, but rarely was a problem. In fact, the informal influence was a great help in coordination across departments and sub-organizations. The informal influence helped the organizations we studied to work better, faster, and smoother. This is a prime area for additional data collection since little proof of these impressions exists.

How can problems of dual pressures in interfaces between units be handled? First, by acknowledging they exist. Individuals we talked to were often placed in "dual pressure" situations and had to respond to multiple people. At the same time, many were hesitant to discuss anything but the chain of command. Second, the interfaces can be actively used to smooth coordination and open communication. The senior NCOs and project engineers we talked to seemed especially good at this.

Organization for Peace Versus War

Are the existing structures adequate organizations for war? War would likely require a move toward the effectiveness end of efficiency/effectiveness continuum (See Chapter One). The diffusion of effort in a war-time scenario would likely result in almost pure program organization. Stated another way, war creates a more uncertain environment, more varied goals, and different technologies. The most flexibility possible is needed, so the move toward a more decentralized structure seems logical. In a long war, however, it may be necessary to shift back to an efficiency emphasis to conserve resources.

What are the trade-offs between organizing for peace vs. war? Can we organize for both contingencies simultaneously? This again brings us to the efficiency/effectiveness problem. These are really two different goals. We can't have both at once, so we must decide where we want to be on the continuum. The structures we studied seemed to have been developed in response to these issues as certain functional elements made their own structural decisions. In peace time we lean toward efficiency but in war we may need the opposite. It is important not to lean too far in the efficiency direction. This is an area of fruitful future emphasis.

Can we realistically expect to change structures if war erupts? No, we will not realistically be able to do this, although some modification will undoubtedly be necessary. That's the bad news. The good news is that the structures we studied seem capable of doing their jobs and responding until some conscious decisions about war time structures can be made.

Future Work

It seems to us there are two very broad options for future work. The first is to extend pilot work such as that presented to other functional areas. This would provide the advantage of being able to broaden the scope of the work still further, and provide more "cognitive maps" of how the models could fit other functional areas descriptively and predictively.

The second option is to look at issues more specifically and in a more controlled way. Studies could address, for example, the concrete interrelations among the elements of the Galbraith model and how these can be used in decisions related to choice of appropriate structure. These elements could then be related to the possible structural alternatives for developing or for selecting organizational structures. Data collection could be expanded to use of survey guided technologies which would allow an array of attitudinal variables to be considered.

During this next phase, it is important to develop a survey, rationale, sampling technique, and methodology for collecting data that will further define relationships that exist between the referenced effectiveness/efficiency model and the Galbraith Model (1977). Included in the approach should be survey items that will allow stating testable hypotheses, determining relationships between models across various structures, and understanding the dynamics of structure, goals, resources, technology, and environment within those structures. The next phase of the study would include data gathering on an appropriate Air Force sample, hypotheses testing, and development of final reports which should provide detailed guidelines that would help commanders develop appropriate structures for mission accomplishment.

A Final Comment

During our work, we were frequently asked if there were magic rules about organization structure. From our viewpoint there is only one magic rule: "It depends." What "it depends" on are elements such as mission, technology, human resources, environment, and the effeciency/effectiveness emphasis we have discussed. What we have done in this report is to identify some of the contingencies that influence structure. While there are no universal rules, clear patterns do exist. These can be used to produce guidelines for commanders in structuring their organizations. We believe this effort has provided both a framework and a background for such efforts.

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